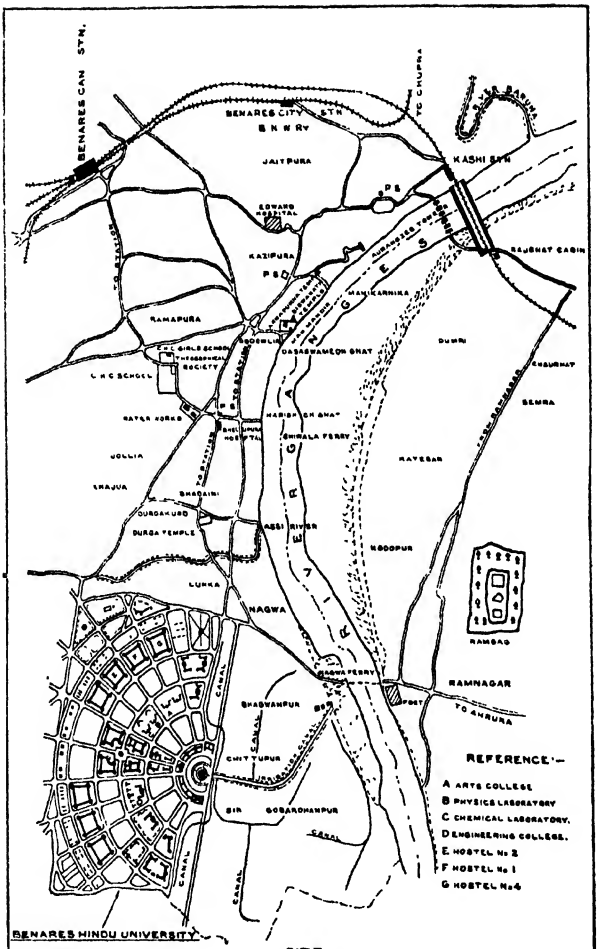
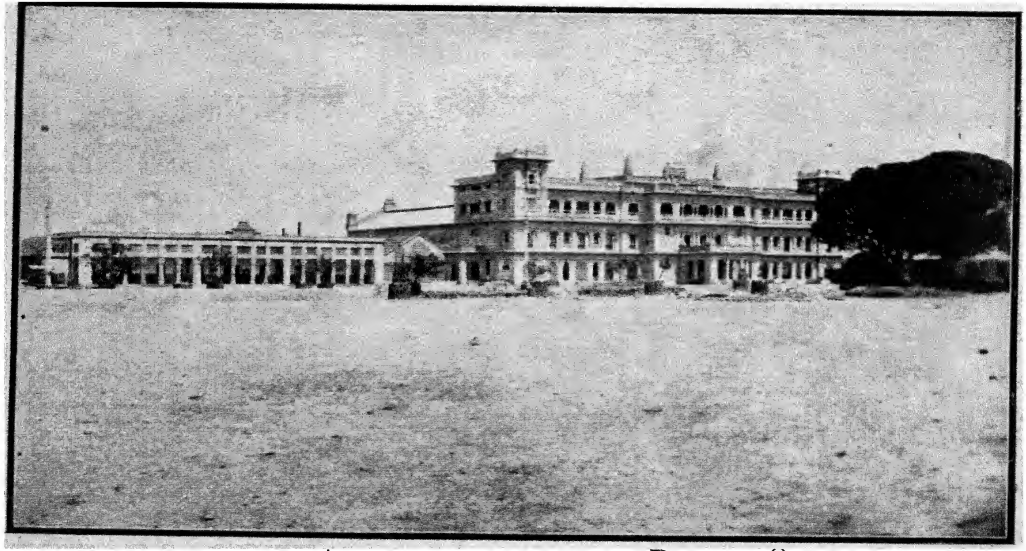
TEXT FLY WITHIN THE BOOK ONLY

With Compliments from the Principal

GENERAL INFORMATION



SITE
OF
BENARES HINDU UNIVERSITY GROUNDS



FRONT VIEW, ENGINEERING LABORATORIES AND DRAWING OFFICES.

FOREWORD.

Provision for imparting instruction in Technological subjects—including the various branches of Engineering—was one of the objects which the promoters of the Hindu University had in view from the time the idea of the University was conceived. The princely generosity of His Highness the Maharaja of Jodhpur and of His Highness the Maharaja of Patiala enabled the University to make a good start towards the realisation of this object. The University as well as the whole Indian community are grateful to their Highnesses for it.

In January, 1919, at the time of the Annual Convocation, the first Workshop of the Engineering College was opened. The building was then barely complete, and a few machines which had been collected with great difficulty owing to the war, had not yet been unpacked. The Chancellor of the University, His Highness the Maharaja of Mysore, and other visitors were favourably impressed by this first building which was of reinforced brick construction. A number of benches, vices, and a certain amount of furniture which had been made for the University, at the Engineering College, Sibpur, enabled us, however, to start work without delay. The machines were erected, shafting lined up, and the power plant, which consisted of a 30 K.W. Belliss Morcome Engine Set, was started within a few months.

In April, 1919, an extra building was started. In this building three class-rooms were provided: one for a Drawing hall; the second for a Mechanics' Laboratory and the third for a Class-room. This building was finished by July. Electric lights and fans were introduced and the work had made sufficient progress to enable us to admit students of the Degree and Diploma Courses before the end of July, so that on the occasion of the visit of His Honour the Lieutenant-Governor of the United Provinces at the beginning of August, 1919, we were able to show him the classes at work and the Workshops in full swing. From that time we have steadily progressed in spite of many difficulties, not the least being the difficulty in getting the necessary funds.

BENARES HINDU UNIVERSITY

LIST OF AUTHORITIES AND OFFICERS.

LORD RECTOR

(*Ex-officio*):

His Excellency the Viceroy and Governor-General of India.

VISITOR

(*Ex-officio*):

His Excellency the Governor of the United Provinces of Agra and Oudh.

CHANCELLOR:

His Highness Maharaja Sir SAYAJI RAO Gaekwar Bahadur, G.C.S.I., G.C.I.E., Maharaja of Baroda.

PRO-CHANCELLOR:

His Highness Raj Rajeshwar Narendra-Shiromani, Shri Maharajadhiraj Sir GANGA SINGH Bahadur, G.C.S.I., G.C.I.E., G.C.V.O., G.B.E., K.C.B., LL.D., Maharaja of Bikaner.

VICE-CHANCELLOR:

Pandit MADAN MOHAN MALAVIYA, B.A., LL.B.

PRO-VICE-CHANCELLOR:

Principal A. B. DHRUVA, M.A., LL.B.

REGISTRAR:

Professor SHYAMA CHARAN DE, M.A.

TREASURER:

The Hon'ble Raja MOTI CHAND, C.I.E.

BOARD OF STUDIES IN ENGINEERING.

1. Charles A. King, B.Sc. (Hons. Eng., London), A.R.C.Sc., M.I.M.E., M.I.S.E., M.I.M., M.I.E. (India).
2. L. D. Coueslant, B.Sc. (Hons. Eng., London), Wh.Ex., M.I.M.E., M.I.E. (India).
3. Bhim Chandra Chatterji, B.A., B.L., B.Sc., M.I.E.E., M.I.E. (India).
4. R. S. Jain, B.Sc., A.M.A.I.E.E.
5. N. P. Gandhi, M.A., B.Sc., A.R.S.M., D.I.C., F.G.S., A.I.M.M.
6. H. K. Sen, M.I.Min.E.
7. P. K. Dutt, M.A. (Cantab).
8. Sohan Lal, M.Sc.
9. G. C. Mukherjee, M.Sc.

COLLEGE STAFF.

Principal:

Charles A. King, B.Sc. (Hons. Eng., London), A.R.C.Sc., M.I.M.E., Wh.Ex., M.I.S.E., M.I.M., M.I.E. (India), Jodhpur Hardinge Professor of Technology.

Vice-Principal:

Leopold D. Coueslant, B.Sc. (Hons. Eng., London), Wh. Ex., M.I.M.E., M.I.E. (India), Patiala Professor of Mechanical Engineering.

PROFESSORS OF MECHANICAL ENGINEERING:

CHARLES A. KING, B.Sc. (Hons. Eng., London), A.R.C.Sc., M.I.M.E., Wh. Ex., M.I.S.E., M.I.M., M.I.E. (India), Jodhpur Hardinge Professor of Technology.

LEOPOLD D. COUESLANT, BSc. (Hons. Eng., London), Wh. Ex., M.I.M.E., M.I.E. (India), Patiala Professor of Mechanical Engineering.

PROFESSORS OF ELECTRICAL ENGINEERING:

BHIM CHANDRA CHATTERJEE, B.A., B.L., B.Sc., M.I.E.E., M.I.E. (India), Patiala Professor of Electrical Engineering.

RANJIT SINGH JAIN, B.Sc., A.M.A.I.E.E.

PROFESSOR OF CIVIL ENGINEERING:

HEMANTA KUMAR SEN, M.I.Min.E.

ASSISTANT PROFESSORS:

SOHAN LAL, M.Sc.	...	Engineering Mathematics.
TOTA RAM SHARMA, M.Sc.	...	Engineering Physics.
N. C. MUKHERJEE, M.Sc.	...	Do. do.
G. C. MUKHERJEE, M.Sc.	...	Electrical Engineering.
K. V. KARDILE, B.Sc. (Science), B.Sc. (Eng.)	...	Do. do.
P. C. DUTT, B.Sc. (Eng.)	...	Do. do.
B. D. KELKAR, B.E.	...	Mechanical Engineering.
B. M. SINGH, B.Sc. (Eng.)	...	Do. do.

DRAWING OFFICES:

ASHUTOSH DAS, Head Draughtsman, Mechanical Engineering.

SURENDRA PRASAD MITTRA, Mechanical Draughtsman.

JOGESHWAR DAS do. do.

R. NANJUNDAYYA, Head Draughtsman, Civil Engineering.

SUKHADEVA PRASAD, Architectural Draughtsman.

S. N. CHOWDHURY, Electrical Draughtsman.

WORKSHOPS:

Superintendent:
B. CHATTERJEE.

Foremen.

MAHABIR PRASAD ...	... Power House.
BENI LALL ...	... Machine Shop.
V. L. KAMAT ...	... Electric Shop.
R. N. TIWARI ...	... Carpenter Shop.
S. C. MUKHERJEE ...	... Motor Shop.
KASHI PRASAD ...	... Smith Shop.

Superintendent of Apprentices:

B. CHATTERJEE.

ENGINEERING CHEMISTRY AND METALLURGY:

(The students attend the department of Mining and Metallurgy for these subjects.)

N. P. GANDHI, M.A., B.Sc., A.R.S.M., D.I.C., F.G.S., A.I.M.M., Head of the Department of Mining and Metallurgy.

V. G. IYER, B.A., Assistant Professor of Assaying.

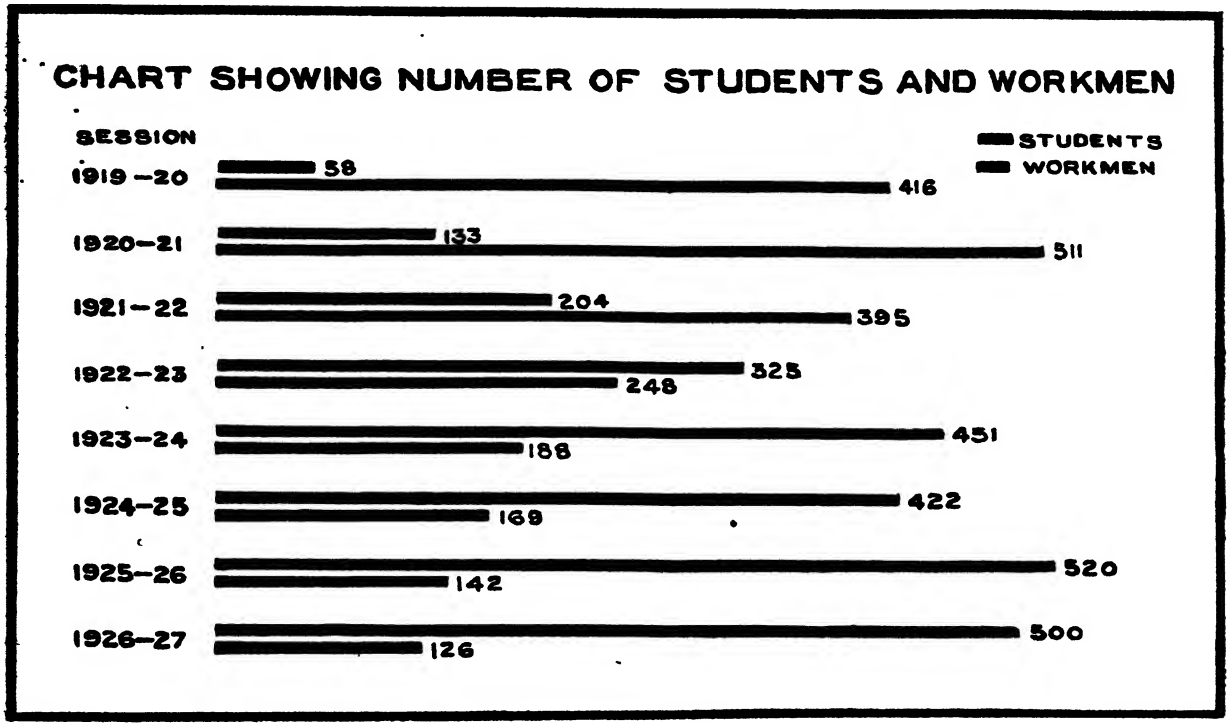


CHART SHOWING NUMBER OF STUDENTS AND WORKMEN
SESSION
STUDENTS
WORKMEN
1919–20
58
416
1920–21
133
511
1921–22
204
395
1922–23
325
248
1923–24
451
188
1924–25
422
169
1925–26
520
142
1926–27
500
126

GENERAL INFORMATION.

Courses of instruction have been arranged at the Engineering College of the Benares Hindu University, so as to give every facility to those who possess ability and promise as practical men, and to train and place each individual in that class which will afford the best scope for his special abilities.

The Workshops and Offices are run on commercial lines as far as is consistent with the efficient training of the students and apprentices.

Each shop is organised and managed as a manufacturing establishment, employing skilled workmen and journeymen, who, together with the students and apprentices, are employed on the various orders to be executed.

Special arrangements are made, whereby students or apprentices may develop the maximum manipulative skill of which they are capable, and at the same time become acquainted with the materials, tools and resources at their disposal, with a minimum waste of time.

The foundation of all training in the Mechanical and Electrical Engineering Courses is in the Workshops, and only those students who show a particular aptitude for practical work, a love for strenuous manual labour, and a reverence for high manipulative skill, are encouraged to continue as students or apprentices in the University Workshops.

The Workshop Courses are co-ordinated with theoretical and scientific courses, designed to provide just that training which is needed in order that the practical man may grasp the principles underlying the processes employed. These courses are also arranged to suit, as far as possible, not only the mental capacity but also the aptitude of the students. Hence we have not one, but a number of parallel courses.

There are *three* Main Divisions or Courses of Training, each with its branches or sub-divisions.

The Main Courses are:—

(1) The Apprentice Course.

(2) The Diploma Course.

(3) The Degree Course.

THE APPRENTICE COURSE.

The Workshops of the University provide facilities for the training of a limited number of apprentices as

1. Blacksmiths.
2. Tin and Copper Smiths.
3. Cabinet Makers.
4. Pattern Makers.
5. Moulders.
6. Fitters.
7. Turners and Grinders.
8. Gear Cutters.
9. Machine Hands.
10. Engine Drivers.
11. Electric Fitters.
12. Electroplaters.
13. Motor Mechanics.
14. Draughtsmen.

The complete period of training, for each trade, is five years, and the apprentices are required to work full time in the shops and under strict workshop discipline.

After five years, a certificate of competency, in any one trade, is granted by the Principal to the apprentice who completes his training in that trade and passes the prescribed examinations in craftsmanship.

Admissions are made in June. Applications on the prescribed form, must reach the office before the 15th of June, and must be accompanied by a registration fee of annas eight.

Candidates over 18 or under 15 years of age are not admitted.

Selected applicants are admitted first on probation for one year, and must complete 250 actual working days, to the satisfaction of the Foreman-in-charge, before being confirmed and before receiving any stipend or allowance from the University.

It is not compulsory, but advisable, that the apprentices should be able to read and write English, say, up to the School Final Standard.

Only those candidates who are strong, healthy and intelligent will be considered. Candidates will be examined by the Medical Officer of the University, who will certify, on the prescribed form, as to their age and fitness for hard manual labour.

The University provides no hostel accommodation for apprentices, hence they have to make their own arrangements for board and lodging. They will be required, however, to satisfy the Foreman of the particular shop, into which they are admitted, that they are either living with relatives, or some responsible guardian, or that some respectable neighbour will be responsible for their conduct and good behaviour.

To facilitate the work, a few Electrical apprentices may, on the special recommendation of the Foreman of the Electric Shop, be admitted to the hostel, if room is available. They will have to pay the usual rent and light charges unless specially exempted.

" Caution Money " of rupees five will have to be deposited in the office before an apprentice can be admitted into the shops. The sum will only be returned on the completion of the course, with deductions, if there be any, for loss of tools or breakages.

The general hours of working are—

8 A.M. to 11 A.M. and 12 noon to 4 P.M. } from Monday to Friday inclusive, with rest period 11 A.M. to 12 noon.

8 A.M. to 2 P.M. ... on Saturday.

Apprentices may be required to work by the Foreman in charge at any time of the day or night.

Holidays—Same as those enjoyed by the workmen.

Casual Leave—Allowed per year—11 days. Stipends are deducted for days absent in excess of this.

Foreman's Annual Report—The Principal requires a report at the end of each year of the progress of each and every apprentice. This report is submitted by the Foreman on a special form with special reference to the (1) Industry, (2) Punctuality, (3) Energy, (4) Obedience, and (5) Ability of the apprentice concerned. Unless this report is satisfactory, no promotion is allowed.

Stipends—From the beginning of the second year until the completion of training, apprentices may receive a monthly stipend as per scale noted below. In addition to such stipend (if awarded), a sum equal to half the amount will be credited to the apprentice every month. In this way a sum will accumulate to the credit of the apprentice. This sum will, after deducting any dues that may occur, be paid to the apprentice on the satisfactory completion of his five years' course of training. If, however, an apprentice leaves the course, or is discharged due to unsatisfactory work or conduct, he will forfeit the whole of the money so standing to his credit.

The scale of stipends that may be available each month.

	Stipend.	Amount credited.
	Rs.	Rs.
1st year (Probationary period) ...	Nil.	Nil.
2nd year	5	2-8
3rd year	8	4
4th year	12	6
5th year	15	7-8

Apprentices who do not satisfy the Foreman will not be eligible for any stipend.

The College Library may be accessible to any apprentice of the 3rd, 4th or 5th year on the recommendation of the Foreman of his shop.

Any apprentice changing his trade will have to start again from the beginning of the first or probationary year in the new trade chosen.

Apprentices desirous of changing to the Diploma Course of the University, must pass the Matriculation Examination and satisfy all the conditions laid down for admission to that course.

Discipline—Strict workshop discipline will be enforced. *Absence* from workshop must be preceded by a written application or followed by a satisfactory written explanation to the Foreman. Absence under any other condition is punished by fine or expulsion.

Unpunctuality is a disqualification. Apprentices are not permitted to enter the shops if they are more than 5 minutes late.

No apprentice is allowed to enter any department but his own without the permission of his own Foreman and the Foreman of the department concerned.

Apprentices must show respect to all University Officials both within and without the College and at all times.

THE DIPLOMA COURSE.

The Diploma Courses are intended to provide a sound practical training coupled with a theoretical and scientific training. They are sub-divided into two courses:—

(1) Mechanical and Electrical Engineering.

(2) Civil Engineering.

Students who take the Diploma Course must at least have passed the Matriculation Examination of a University established by Act of legislature.

The course of study for the Licentiateship covers in all four years, and the full Diploma of Associateship of the Benares Hindu University will be awarded to the Licentiate who is able to produce evidence which will satisfy the Syndicate that, after obtaining the Licentiateship, he has had not less than two years' successful practice of his profession, and that he has added substantially to his knowledge and capability. Candidates for the Licentiateship will be required to pass two University Examinations, *viz.*, the Preliminary and the Licentiateship, at both of which the lowest percentage for a bare pass is 60 per cent.

The first two years are devoted to a preliminary study of the Arts and Science common to Mechanical, Electrical and Civil Engineering, and in acquiring elementary drawing office and workshop technique. The Preliminary Examination is held at the end of the second year, and must be passed before promotion to the third year.

The third and fourth years are devoted to the Special Study of Mechanical and Electrical or Civil Engineering, and are followed by the Final Examination for the Licentiateship in the branch chosen.

THE DEGREE COURSE.

The Degree Courses are intended to provide a sound practical training, coupled with a more advanced theoretical and scientific training than can be given to the Diploma students. Students who take the Degree Course must at least have passed the Intermediate Examination with Mathematics, Physics and Chemistry, of a University established by Act of legislature.

The course is an advanced one. The theoretical standard is not less than that of the London University, and the practical standard is such that a student who completes the course will be not only familiar with modern workshop processes but also himself a workman of fair ability.

The course of study and practical training for the University Degree in Mechanical and Electrical Engineering covers in all five years, of which the fifth year is entirely devoted to practical training, which is carried out at some establishment outside the University.

Candidates will be required to pass four University Examinations:—

1.	At the end of the 1st year		...	I.Sc., Part I.
2.	Do. do.	2nd year	...	I.Sc., Part II.
3.	Do. do.	3rd year	...	B.Sc., Part I.
4.	Do. do.	4th year	...	B.Sc., Part II.

The Degree of B.Sc. in Engineering will be awarded to those students who produce evidence which will satisfy the Syndicate that they have spent not less than one year (250 working days) in practical work or research, after passing the Final Examination for B.Sc., Part II.

CONDITIONS FOR ADMISSION.

The "minimum" standard required for admission in the Degree Course is that of the Intermediate Science with

(1) Physics,

(2) Chemistry, and

(3) Mathematics.

Applicants for the above course will note that the standard is a high one. If the applicant has had some difficulty in passing I.Sc. Examination, he is advised not to apply for the Degree Course, as he will not be able to follow the course successfully. Candidates with "third" class qualification in I.Sc. Examination are not likely to be considered except under special circumstances.

N.B.—If a 1st Year Degree Class student fails to satisfy the examiners in the final examination, he will not be re-admitted in the 1st Year Degree Class. His application for the Diploma Course may, however, be considered with other applications, if he chooses to apply for such a course. A 1st Year Diploma student having failed, will, under no circumstances, be re-admitted.

The "minimum" standard required for admission in the Diploma Course is that of the Matriculation with

(1) Mathematics,

(2) Physics, and

(3) Chemistry.

Here also, candidates with "third" class qualifications are not likely to be considered.

Only those students who are keen to help forward the industrial development of the country, and are prepared to make strenuous and continuous effort, both physical and mental, for that purpose, need apply.

There are no "Guaranteed" Appointments and no "Guaranteed" Prospects.

Age limit—No candidate over 21 years of age can be admitted except under special circumstances. (B.Sc. students, if they are slightly over age, may be considered.)

Applications:—

(1) Applications must be made in the Form prescribed by the college, and should reach Principal's office before 15th June.

(2) Incomplete applications will not be considered.

(3) Registration fee of rupees two must be sent by money-order. (Registration fee is not refundable.)

(4) Letters of recommendation are considered only inasmuch as they certify the applicant's character, and ability.

The students applying for admission in the Engineering College, Benares Hindu University, either for Degree or Diploma Courses from any Indian State as a State Scholar, must comply with the following:—

(1) A certificate stating that he is a *bona-fide* subject of the State is to accompany the application.

(2) The application must be forwarded through the Minister of Education or Finance Member.

(3) He should also state if he is recipient of any scholarship from the Durbar.

At the time of final admission the following will be required:—

(1) University and College Certificates in original.

(2) Marks obtained at the University Examination (if available).

(3) A character certificate from the Principal of his School or College.

(4) A Medical Certificate (in the prescribed form) as shown on the back of the Application Form supplied herewith, signed by a Civil or Assistant Surgeon.

(5) References as to character, ability and sportsmanship.

(6) Certified copies of the entries against the name of the applicant in the enrolment register of the University from which he comes.

Application for admission must reach Engineering College Office on or before *15th June*, after which no application will be considered. To avoid disappointment, apply early in March, April or May. The prospective candidate may send his last examination-result by wire if it is not available at the time of applying.

The Admission Form with true copies of the certificates is to be forwarded under registered cover (marked on the envelope "Application for admission into Degree/Diploma Course") to the Principal, Engineering College, Benares Hindu University. When it is received, an acknowledgment will be sent as follows:—

"ENGINEERING COLLEGE,
BENARES HINDU UNIVERSITY.

Dated the.....192

No.....

Your application in the prescribed form $\frac{\text{with registration fee}}{\text{without registration fee}}$ has been received. Your name $\frac{\text{has been}}{\text{has not been}}$ registered. The result will be communicated in due course.

Principal."

The selected candidate will receive a printed card as follows :—

" *Telegraphic Address* " **BENCO** "

ENGINEERING COLLEGE,
BENARES HINDU UNIVERSITY.

Benares, the.....192

No. A/

You have been SELECTED for admission into the DEGREE or the DIPLOMA COURSE of this College. The session starts on July, 19 . If you do not present yourself, or the fee which amounts to Rs. 59/12 (fifty-nine rupees twelve annas for admission, etc.) does not reach the office on or before the above-mentioned date, your admission is automatically cancelled.

Principal."

N.B.—The candidate must present the card at the time of admission.

If the candidate is not selected, he will also be informed as follows :—

" *Telegraphic Address* " **BENCO** "

ENGINEERING COLLEGE,
BENARES HINDU UNIVERSITY.

No..... *Benares, the.....192*

Reference—Your application dated

I regret that you are not among the candidates selected for admission into this College.

Principal.

The selected candidate will be required to pay admission and other dues (which amount to Rs. 59-12) and to join the college before the opening date (usually 2nd Monday of July). The selected candidate is advised to send the money-order mentioning the admission number (such as A/51 or A/96) directly he receives the " Selection " Card, to ensure a seat in the college as well as in the hostel. If the selected student does not report himself in the Hostel a day earlier than the opening date, or his dues are not received on or before the opening date, his place will be given to another. If there is not sufficient time for ordinary money-order, a telegraphic money-order may be sent.

Unless the student gets permission beforehand, he *must not come to Benares on the chance of getting admitted.*

To avoid confusion, all communications must be sent to

THE PRINCIPAL,

" ENGINEERING COLLEGE,"

P. O. HINDU UNIVERSITY, BENARES.

If any reply is desired, a duly stamped and sufficiently addressed envelope must be sent. If a reply is required by telegram regarding the result of selection, a telegraphic form, duly stamped and sufficiently addressed, must be sent.

Reference No. (*e.g.*, A/40) and date must be given in any kind of enquiry, otherwise delay is likely to occur in reply.

FEES AND OTHER EXPENSES.

Admission Fees (to be paid at the time of admission only) :—

		Rs.	as.
1.	Admission Fee ...	7	0
2.	Enrolment Fee ...	2	0
3.	Caution Money Deposit ...	25	0
4.	Library Fee ...	3	0
5.	Tuition Fee ...	15	0
6.	Room Rent ...	2	0
7.	Athletic Club Entrance Fee ...	1	0
8.	Athletic Club Monthly Fee	0	8
9.	Electric Light ...	1	0
10.	Medical Examination Fee	1	0
11.	Medicine (Monthly) ...	0	4
12.	Common Room ...	2	0
	Rs.	59	12

In case of withdrawal from the College in the very month of admission, only the Caution Money is refundable.

A sum of Rs. 18-12 is payable as monthly fees for eight months as per detail given:—

	Rs.	as.
Tuition Fee ...	15	0
Room Rent ...	2	0
Athletic Club ...	0	8
Electric Light	1	0
Medicine ...	0	4
Rs.	18	12

N.B.—The probable monthly expense for a student tudying in this college is from Rs. 40 to Rs. 50.

No tuition fee is charged during the fifth year of practical training.

Fine for late payment of fees—Annas two per day up to a maximum of Rs. 3.

EXAMINATION FEES.

A fee is charged by the University for the following examinations:—

		Payable at the end of
I.Sc. (Engineering), Part I ...	Rs. 20	1st year.
I.Sc. ,, ,, II ...	,, 20	2nd year.
B.Sc. ,, ,, I ...	,, 30	3rd year.
B.Sc. ,, ,, II ...	,, 30	4th year.
Preliminary Examination ...	,, 20	2nd year.
Licentiate ,, ...	,, 30	4th year.

The above fees are to be paid about a month and a half before the commencement of each examination. If for any reason the student cannot appear in the examination, the fee is not refunded.

Examination fees will not be accepted unless all the College dues are paid.

Residence—The College is a residential one. No student is allowed to live outside the hostel premises except with the permission of the authorities. Permission is granted in cases where the student will reside with his guardian. Both Degree and Diploma students live in the same hostel and pay the same hostel fees.

Messing arrangements are managed by the students themselves. Approximate monthly cost of messing is Rs. 15 to 20 only.

There are 44 kitchens for different sects, each of which contain about 10 to 15 members. There is a separate kitchen for Muhammadan students.

IMPORTANT RULES TO BE OBSERVED BY BOARDERS.

1. The allotment of seats will rest entirely with the Assistant Warden of the block, who may change the seat at any time he might think fit. No student shall change his room except with the permission of the Assistant Warden or Assistant Wardens concerned.

2. Each mess, when managed by students, shall, as a rule, consist of not less than ten boarders for which a kitchen will be provided free of charge.

3. Separate kitchens for a smaller number of students than ten will, if available, be provided on payment of Rs. 2 per mensem therefor, but in cases where they are required owing to religious or caste considerations, no rent will be charged for them.

4. Private servants in the hostel must be approved by and be subject to the authority and discipline of the Warden and Assistant Warden.

5. All complaints against hostel servants shall be made to the Assistant Warden as soon after the occurrence as possible. But a servant should, under no circumstances, be abused or beaten. A breach of this rule will render a boarder liable to a fine, while a repetition of such an offence will render him liable to expulsion.

6. Non-vegetarian food will not be allowed to be brought within the hostel area. Students who cannot do without non-vegetarian food may use a kitchen which has been specially provided for the purpose outside the hostel area.

7. No boarder shall accommodate a guest in his room without the permission of the Assistant Warden. Permission to stay will not ordinarily be given for more than one day.

8. The roll will be called daily between 8 and 8-15 P.M. No boarder shall be absent from the hostel after call without leave previously obtained in writing. Absence from roll call without leave shall render a student liable to a fine of Re. 1 for the first time, and a repeated breach of this rule by any student shall render him liable to further disciplinary action which may amount to expulsion. Students who desire to be absent at the time of the roll call, must apply in writing before 10 A.M. on the same day, and should not leave the hostel without ascertaining that the application has been granted.

9. The hours of rest at night in the hostel are from 10 P.M. to 5 A.M. A bell will ring every day at 10 P.M. It is recommended that students should generally go to bed at that hour and rise not later than 5 A.M. when the bell will ring again every morning.

10. From 6 to 7 A.M. in the morning and after 8-15 P.M. in the evening, silence must specially be observed in the hostel to enable students to pursue their studies quietly by themselves. Except in case of necessity, every student is expected to remain in his room during these hours and to devote his time to his studies.

11. Any boarder found guilty of gross misconduct will be removed from the hostel by the Warden with the approval of the Pro-Vice-Chancellor.

12. No boarder shall leave or remain outside Benares during term time except with the written permission of the Assistant Warden. Permission will not be usually granted without a letter from the parent or guardian. Such application shall clearly state the number of days for which leave of absence is requested and the reason therefor.

13. Except with the permission of the Assistant Warden no music will be allowed in the hostel outside the hours prescribed therefor, *viz.*, between 4-30 and 7-30 P.M. on working days. The Assistant Warden may stop music at any time if he considers it desirable to do so.

14. For acts of misconduct of a less serious kind, a boarder may be fined by the Assistant Warden up to a limit of Rs. 5, or the misconduct may be noted against him in his Conduct Book. If, in the opinion of the Assistant Warden, the number of such acts and their seriousness merit the punishment of expulsion from the hostel, wholly or for a period, he shall submit the case to the Pro-Vice-Chancellor through the Warden.

15. Boarders shall not hold any meetings or organise any activities in the hostel premises other than those which have been recognised as falling within the regular activities of the University students, without the permission of the Assistant Warden.

16. No notice shall be posted or circulated in the hostel without the countersignature of the Assistant Warden.

17. Except when prevented by ill-health or some other reasonable cause, every student must take part in some game or sport, or take some physical exercise every day.

18. Every student is expected to perform *Sandhya* or say his prayer morning and evening by himself. But attendance at the common prayer, religious lectures and *Ekadashi* and other *Kathas* which may be prescribed from time to time, and a list of which will be exhibited at the hostel notice board, shall be compulsory in the case of all Hindu students. Absence from the religious instruction classes and such lectures and *Kathas* without good cause shall render a student liable to such penalty or penalties as the Students' Residence Committee may think fit to impose.

Attendance at the daily *Katha*, which is held for an hour after lamp-light in the hostel ground, shall be optional.

19. Every student must attend the University functions, attendance at which is made obligatory by the Vice-Chancellor or Pro-Vice-Chancellor except when he is excused or prevented by some reasonable cause from doing so.

20. The inmate of a room is responsible for the care of all fittings and furniture in and near his room. Before leaving the hostel at the end of the session, he must return all the furniture to his Assistant Warden and obtain a receipt therefor. Any damage other than by fair wear and tear will be chargeable to him.

21. The Assistant Warden shall take such action as he deems necessary to ensure general cleanliness in the hostel premises. No student shall bathe, wash or keep water pots in the verandah, cook any food in the room or commit any other nuisance within the hostel area.

22. Boarders will be ordinarily attended by the Medical Officer of the hostel free of charge.

23. An outside medical practitioner may be called by a boarder with the knowledge of the Hostel Medical Officer or the Assistant Warden, but in such cases the fees of the doctor consulted must be paid by the boarder.

24. Boarders suffering from any infectious disease shall be segregated in quarters provided for the purpose.

25. The Assistant Warden, on the recommendation of the Medical Officer, can and, with the approval of the Pro-Vice-Chancellor, shall exclude from the hostel a boarder suffering from any disease which renders the sufferer unfit to reside in the hostel.

26. Every boarder shall, on admission, be examined by the Medical Officer and thereafter periodically at least once a year, and a full record of the examination shall be kept with the Assistant Warden in the form prescribed by the Students' Residence Committee.

Besides the prescribed text-books, every student must procure the following at the time of admission:—

I. For Drawing Office work:—

Stanley's Drawing Instruments.

		£	s.	d.
M2057.	Bow Pencil, 3¾-inch, with sector head joint, double knee joints and B needle points ... ... One	0	14	0
M2057.	Bow Ink do. do. ... One	0	14	0
M2043.	Divider, 5-inch, with sector jointed head and Stanley's improved hair spring ... ... One	0	9	6
M2111.	Drawing Pen, Stanley's improved One	0	8	6
M2093.	Spring Bows, 3-inch, Ink, Pencil and Divider with B needle points One set	1	10	0
M2972.	Rectangular Protractor, 6-inch, best quality Ivory ... ... One	0	12	0
M3059.	Stanley's Transparent Celluloid Set Squares of best quality, 6″×45°, 8″×60° One pair	0	3	0
M2788.	French Curve, transparent celluloid, No. 5, Stanley's ... One	0	2	6
	Stanley's Boxwood, Oval Section Engineers' Scale, 12-inch, containing $\frac{1}{3}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{3}{4}$, $\frac{1}{2}$ and full size scales ... One	0	4	6
		£4	18	0
	Approximately ... Rs.	75	0	0

II. For Workshop use:—

1. Carpenter's Chisels—$\frac{1}{8}''$, $\frac{1}{4}''$, $\frac{1}{2}''$, $\frac{3}{4}''$, $1''$ ... One of each size with boxwood handles.
2. Steel Foot-rule—one foot ... One.
3. $1\frac{1}{2}''$ lock—galvanized or brass ... One (for Workshop Cupboard).

III. For Hostel use:—

1. One Bucket (*Balti*).
2. One Dish (*Thala* or *Thali*).
3. One Cup (*Katora*, *Bati*).
4. One Tumbler.
5. One $2''$ Lock and Key with duplicate keys for their room.
6. One Mosquito Net.
7. One Lantern.

SANDWICH SYSTEM.

According to this system the Session (July to April) is divided into two parts, one half being devoted entirely to practical work and the other half entirely to theoretical class work.

By working on this system, students are able to make more satisfactory progress and to attain greater facility at practical work than is possible by attending workshop for short and disjointed periods. It also enables the third and fourth year students to take their practical training in approved Mills, Factories, Power Stations, etc., outside the University.

N.B.—The following is a list of employers of 3rd and 4th year students during the seesion 1926-27 :—

1. Ajmer Power House.
2. Hydro-Electric Power House, Naini Tal.
3. Tata Iron and Steel Company.
4. D.-H. Railway, Tindharia.
5. Tata Hydro Electric Power Supply, Ld., Bombay.
6. Shillong Hydro-Electric Co., Ld.
7. Jessop & Co., Calcutta.
8. Bengal-Nagpur Railway Co., Ld., Kharagpur.
9. Tata Hydro-Electric Power Supply, Ld.
10. The Andhra Valley Power Supply Co., Ld. Bombay.
11. Heatly & Gresham, Ld., 9, Fort Street, Bombay.
12. E. I. Railway Loco. Workshop, Jamalpur.
13. Vulcan Iron Works, Ld., 172, Lower Circular Road, Calcutta.
14. Richardson & Cruddas, Engineers and Iron Founders, Bombay.
15. His Highness The Nizam's Mint Workshop.
16. The Calcutta Tramways Co., Ld., Power Station, Calcutta.
17. Messrs. Burn & Co., Ld., Ship Builders, Howrah.
18. Nainital City Board Electric Supply.
19. Kotah State P.W.D.
20. B.-B. & C. I. Railway Co., Ld., Ajmer.
21. Upper India Paper Mills Co., Ld., Lucknow.
22. The Commissioners for the Port of Calcutta, King George's Dock.

23. The Indian Iron and Steel Co., Ld.
24. The Calcutta Electric Supply Corporation, Ld., Calcutta.
25. Electric Power Supply Works, Jammu and Kashmir.
26. The U. P. Electric Supply Co., Ld., Lucknow.
27. Messrs. James Park and Co., Narkaldanga Jute Mills, Calcutta.
28. Wellington Engineering Works (India), Ld., Calcutta.
29. Delhi Electric Supply and Vickers & Peters, Ld.
30. Water Works, Benares.
31. Government Power House, Delhi.
32. Cawnpore Electric Supply Corporation, Ld.
33. Cochin State Forest Tramway, Chalakuddi.
34. Rohilkund and Kumaon Railway Co., Ld., Izatnagar.
35. Lahore Electric Supply Co., Ld., Lahore.
36. Water Works Power House, Patiala.
37. Bombay Electric Supply & Tramway Co., Ld., Bombay.
38. U. P. Electric Supply Co., Ld., Allahabad.
39. The Eastern Coal Co., Ld., Bhourah, Jharia.
40. Govt. of Mysore Electric Department.
41. B.-B. & C. I. Railway Electrical Workshop, Bulsar.

Working hours at the College and Workshop for students:—

Monday to Friday	8 A.M. to 11 A.M. 1 P.M. to 4 P.M.	Meal and rest time 11 A.M. to 1 P.M.
Saturday	8 A.M. to 11 A.M.	No work in the afternoon.

LIST OF HOLIDAYS.

Rathajatra	...	... 1 day.
Nagpanchami	...	... 1 day.
Janmasthami	...	... 2 days.
Anant Chaudas	...	... 1 day.
Matrinavami	...	... 1 day.
Bishwakarma Puja	...	... 1 day.
Mahalaya Amawas	...	... 1 day.
Durga Puja and Dewali	...	... 30 days.
Christmas	...	... 10 days.
New Year's Day	...	... 1 day.
Makar Sankranti	...	... 1 day.
Basanta Panchami	...	... 2 days.
Shiva Ratri	...	... 2 days.
Holi	...	... 2 days.
Ramnavami	...	... 1 day.
Good Friday	...	... 1 day.
Chaitra Sankranti	...	... 1 day.
Dashera	...	... 1 day.
King-Emperor's Birthday		... 1 day.

N.B.—Besides the above holidays, the College will be closed on account of Lunar and Solar Eclipses, if visible during the year, and on the Somavati Amawases.

The College will remain closed for about two months for the Summer vacation.

Muhammadans will be given leave on the occasions of Id, Bakrid and Moharrum.

EXAMINATIONS.

Before being admitted to each examination, either in Degree or Diploma, the candidate must produce certificates to show that he has satisfactorily completed the course for the Examination, that his " Attendance " in College and in Workshop has been more than 75 per cent., that his conduct has been satisfactory, and that he has obtained not less than 60 per cent. of the total marks awarded for the Sessional Work in the Shops, Laboratories and Drawing Offices. A satisfactory report from his employer for any practical work that he may do outside the College will also be required. A daily report is to be kept by the student and submitted to the authorities on his return to the College.

RULES OF COLLEGE DISCIPLINE.

Students are bound by the rules of discipline laid down by the University and must obey such orders as may be issued from time to time by the Principal.

Religious instruction and lectures are delivered by qualified Pundits to all Hindu students and regular *Ekadashi Kathas* are held twice a month. All Hindu students are required to attend this function.

Students are held responsible for any books, machines, instruments, tools and materials placed in their charge. In case of loss or damage arising from carelessness they must pay the cost.

Loose Garments are not allowed in the Workshops or near running machinery. Students from Drawing Office or Classes

are not admitted in the shops in such garments. Students must provide themselves with Khaki Shirts and Shorts. In order to avoid accident Punjabi and Sikh students are required, while in Workshops, to make their turbans as small and compact as possible.

University authorities do not allow any compensation to any student meeting with an accident of whatsoever kind in the shop.

Annas two per day are charged for late payment of fees to a maximum of Rs. 3 (rupees three) when the student's name is struck off the College Rolls, and the attendance in class or in workshops, wherever the student happens to be working, is not taken down or counted from the date of order. No excuse is accepted. (Guardians are requested not to put their wards to unnecessary anxiety and risk.)

No student is permitted to enter a Workshop, Drawing Office or Laboratory unless invited to do so by the Teacher in charge of it.

No student is permitted to enter a Class Room, Workshop or Laboratory more than five minutes late.

Every teacher in the College has authority to demand immediate obedience and respect from any student, either within or without the College and at all times.

In case of serious misconduct or habitual idleness the punishment may be accompanied by the entry of the offender's name in the Conduct Book. When the name of a student has been entered thrice in the Conduct Book, he shall be liable to expulsion from the College. A student must complete his course for the Degree or Diploma *within six years.*

A student desiring leave of absence must apply to the Principal. For absence without leave, he will be liable to a fine of four annas a day or period, and if the absence exceeds a fortnight, his name may be struck off.

No student who has suffered from any infectious disease shall be allowed to attend his class without a medical certificate stating that he is free from infection.

Students are required to keep the Principal informed of their addresses. Any alteration of address must be communicated without delay.

A student expelled for idleness or misconduct shall forfeit all fees and privileges.

ATHLETIC CLUB.

All students must join the Athletic Club. The club includes the following sections:—

Football.

Cricket.

Hockey.

Tennis.

Gymnasium.

Volley Ball.

Basket Ball.

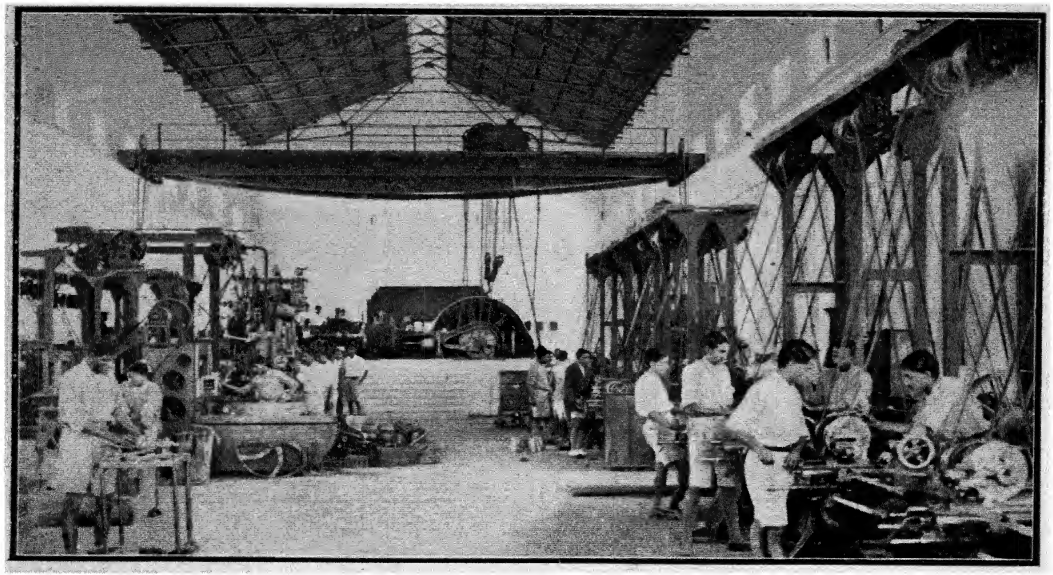
Badminton.

The club is managed by a committee elected at the beginning of every session. This committee is in charge of all the athletic activities of the College, and makes its own budget from the grant made for the athletic department by the University Council. The Principal is the *ex-officio* president of the athletic club.

UNIVERSITY TRAINING CORPS.

There is at present a detachment of the " D " Company, 3rd (U. P.) Battalion U.T.C., I.T.F., consisting of 3 platoons, for the military training of students in the Benares Hindu University, and there is every likelihood of this detachment being raised to a full company, consisting of 4 platoons, shortly, with the sanction of the Government. The platoons are open for enrolment only to those Engineering College students who are sufficiently developed physically to fulfil military requirements. This training is optional. Inteding applicants for enrolment in the crops must note that withdrawals from the corps, when once enrolled, are not allowed, as long as they stay in the University for study, on any grounds whatsoever, except on a Medical Certificate for permanent deterioration of health. They should also note that they may be required to spend a portion of their Summer or Puja Vacation (about 15 days) in the Camp for Military Training, as they cannot leave colleges for this during the courses of their study. The parades are generally held at about 5 or 5-30 in the evening, for one hour, three times a week. When inconvenient owing to any other College or University activities, they are held in the morning at about 6 or 6-30.

SYLLABUSES



PORTION OF MACHINE SHOP.

REGULATIONS FOR DEGREE COURSE EXAMINATIONS.

Bachelor of Science (Engineering).

1. Before being admitted to the Engineering College of the Benares Hindu University, a candidate, who wishes to take the courses for the degree of Bachelor of Science (Engineering), must have passed the Intermediate Examination with Mathematics, Physics and Chemistry of the Benares Hindu University or of any other Indian University or the Board of High School and Intermediate Education established by Act of the Legislature or the corresponding examination, with the same subjects, of any other University in a British Province or any Native State which, on the advice of the Syndicate, shall at any time be recognised by the Government of India as qualifying for admission, provided that a student who passed his B.A. or B.Sc. examination with Mathematics and his Intermediate Examination with Mathematics and only one of the remaining subjects mentioned in the preceding part of the Regulation shall be eligible for admission to the courses for the degree of Bachelor of Science in Engineering if he passes a special examination to be conducted by the Principal of the Engineering College of this University at the commencement of the session at this University in the remaining subjects in the course prescribed in Pure Science for the Intermediate Examination in the Faculties of Arts and Science. He must also produce a certificate, signed by the Principal of his College, that his conduct and behaviour have been satisfactory.

2. The Degree Course covers in all five years, the first two years being devoted to the Intermediate Course in Engineering, the third and the fourth years to the Degree Course, and the fifth year solely to practical training or research.

3. Candidates will be required to pass four examinations:—

First Year	...	Intermediate Examination, Part I.
Second Year	...	Intermediate Examination, Part II.
Third Year	...	Degree Examination, Part I.
Fourth Year	...	Degree Examination, Part II.

4. Before being admitted to each one of the examinations the candidate must produce certificates to show that he has satisfactorily completed the course prescribed for that examination, that his conduct in the College and in the Workshops has been satisfactory, that he has obtained not less than 60 per cent. of the total marks awarded for sessional work in the Shops, Engineering Laboratories, and at any special workshop examinations that may have been held.

Intermediate Examination, Part I.

5. Intermediate Examination, Part I, shall be held once a year at Benares, at such time and on such dates as the Syndicate may prescribe.

6. No candidate shall be admitted to the examination unless he has prosecuted a regular course of study for not less than one year in the Engineering College of this University.

7. A candidate shall apply to the Registrar in such form as the Syndicate may prescribe. His application and fee shall be despatched through the prescribed channel so as to reach the Registrar at least thirty days before the commencement of the examination.

8. A candidate who has completed a regular course of study in the University or in a constituent college for the Intermediate Examination in Engineering, Part I, but fails to pass, or to appear may be admitted with the permission of the Syndicate without further attendance to a subsequent Intermediate Examination in Engineering on a new application and on payment of a further fee.

9. The subjects of examination shall be:

(1) Mathematics.

(2) Applied Mechanics.

(3) Engineering Chemistry.

(4) Building and Surveying.

(5) Metallurgy.

(6) Heat Engines.

(7) Mechanical Drawing.

(8) Practical Geometry.

(9) Electrical Engineering.

Intermediate Examination, Part II.

10. The Intermediate Examination, Part II, shall be held once a year at Benares, at such time and on such dates as the Syndicate may prescribe.

11. No candidate shall be admitted to this examination unless he has passed the Intermediate Examination, Part I, and prosecuted a regular course of study thereafter for not less than one year in the Engineering College of this University.

12. A candidate shall apply to the Registrar in such form as the Syndicate may prescribe. His application and fee shall be despatched through the prescribed channel so as to reach the Registrar at least thirty days before the commencement of the examination.

13. A candidate who has completed a regular course of study in the University or in a constituent college for the Intermediate Examination in Engineering, Part II, but fails to pass or to appear, may be admitted with the permission of the Syndicate without further attendance to a subsequent Intermediate Examination in Engineering on a new application and on payment of a further fee.

14. The subjects of the examination shall be:

(1) Mathematics.

(2) Heat Engines.

(3) Applied Mechanics.

(4) Practical Geometry.

(5) Electrical Engineering.

(6) Mechanical Drawing.

Bachelor of Science (Engineering) Examination, Part I.

15. The examination for the degree of Bachelor of Science (Engineering), Part I, shall be held once a year, at Benares, at such time and on such dates as the Syndicate may prescribe.

16. No candidate shall be admitted to the above examination, unless he has passed the Intermediate Examination, Part II, of this University, and prosecuted a regular course of study thereafter for not less than one year in the Engineering College of this University.

17. A candidate shall apply to the Registrar, in such form as the Syndicate may prescribe. His application and fee shall be despatched through the prescribed channel, so as to reach the Registrar at least thirty days before the commencement of the examination.

18. A candidate who has completed a regular course of study in the University or in a constituent college for the B.Sc. (Engineering) Examination, Part I, but fails to pass, or to appear, may be admitted with the permission of the Syndicate without attendance to a subsequent examination for the same degree, on a new application and on payment of a further fee.

19. The examination shall be conducted by means of papers and may include a *viva voce* test in subjects which admit of it.

20. The subjects of examination shall be:

(1) Strength of Materials.
(2) Theory of Structures.
(3) Structural Design.
(4) Theory of Machines.
(5) Hydraulics.
(6) Mechanical Drawing.
(7) Heat Engines.
(8) Engine Design.
(9) Electrical Engineering, Paper I.
(10) Electrical Engineering, Paper II.
(11) Design of Electrical Machines.
(12) Design of Electrical Installations.

Bachelor of Science (Engineering) Examination, Part II.

21. The examination for the degree of Bachelor of Science (Engineering), Part II, shall be held once a year, at Benares, at such time and on such dates as the Syndicate may prescribe.

22. No candidate shall be admitted to the above examination, unless he has passed the Degree Examination (Engineering), Part I, of this University, and prosecuted a regular course of study thereafter for not less than one year in the Engineering College of this University.

23. A candidate shall apply to the Registrar, in such form as the Syndicate may prescribe. His application and fee shall be despatched through the prescribed channel, so as to reach the Registrar at least thirty days before the commencement of the examination.

24. A candidate who has completed a regular course of study in the University or any constituent college for the B.Sc. Degree Examination in Engineering, Part II, but has failed to pass or to appear at the said examination, may be admitted with the permission of the Syndicate to a subsequent examination in the same subject and in the same branch on a new application and on payment of a further fee.

25. The examination shall be conducted by means of papers, and may include a *viva voce* test, in subjects which admit of it.

26. The subjects of examination shall be:

(1) Properties of Materials.
(2) Theory of Structures.
(3) Structural Design.
(4) Hydraulics.
(5) Hydro-electric Technology.
(6) Machine and Engine Design.

(7) Heat Engines.
(8) Electrical Engineering, A.
(9) Electrical Engineering, B.
(10) Design of Electrical Installations.
(11) Business Method.
(12) Workshop Management.
(13) Craftsmanship (or Approved External Practice).

Fifth Year's Course.

27. Candidates who have passed Part II of the Examination for the Degree of Bachelor of Science (Engineering), shall be admitted to the Degree of Bachelor of Science (Engineering) only on producing evidence that will satisfy the Syndicate that they have spent not less than one year in practical work or research.

REGULATIONS FOR DIPLOMA COURSE EXAMINATIONS.

Engineering Diplomas.

1. Before being admitted to the Engineering College of the Benares Hindu University, a candidate, who wishes to take the courses for the Engineering Diplomas, must have passed the Admission Examination of the Benares Hindu University or the Matriculation Examination of an Indian University established by an Act of the Legislature or any School Leaving or High School Examination recognised by the Syndicate as equivalent to it. He must also produce a certificate signed by the Principal of his School or College that his conduct and behaviour have been satisfactory.

2. The Diploma Course for the Licentiateship in Engineering covers in all four years, the first two years being devoted to the Preliminary Course in Engineering and the third and fourth years to specialization as a University student in one of the branches of Engineering hereinafter mentioned.

3. The Diploma of Associate in Engineering may be awarded to the Licentiate who has been engaged in responsible Engineering Work for a period of not less than two years after he has gained his Licentiateship.

4. Candidates will be required to pass two University Examinations.

The Preliminary Engineering Examination at the end of the second year.

The Final Diploma Examination at the end of the fourth year.

5. Before being admitted to each one of the examinations, the candidate must produce certificates to show that he has satisfactorily completed the course prescribed for that examination, that his conduct in the College and in the Workshops has been satisfactory, that he has obtained not less than 60 per cent. of the total marks awarded during the preceding sessions for work done in the Shops, Drawing Offices and Engineering Laboratories, and of the total marks awarded at the Periodical Examinations that have been held during the preceding sessions.

Preliminary Examination for Engineering Diplomas.

6. The Preliminary Diploma Examination shall be held once a year, at Benares, at such time and on such dates as the Syndicate may prescribe.

7. No candidate shall be admitted to this examination, unless he has prosecuted a regular course of study and practice for not less than two years in the Diploma Course of the Engineering College of this University.

8. A student who has been entered for the Degree Course in Engineering may, with the special sanction of the Principal, be transferred to the Diploma Course at any time during the first two years, counting the time he has studied in the Degree Course towards the time required for the Diploma Course. In such cases the Principal at his discretion may waive the requirement of a 60 per cent. minimum of the marks secured in the Degree Classes and Examinations.

9. A candidate shall apply to the Registrar, in such form as the Syndicate may prescribe. His application and fee shall be despatched through the prescribed channel, so as to reach the Registrar at least thirty days before the commencement of the examination.

10. A candidate who fails to pass, may be re-admitted to a subsequent examination, on a new application and payment of a further fee, provided he shall have prosecuted a regular course of study for one year in the Engineering College of this University since the date of the last examination.

11. The subjects of the examination shall be:

Group I	...	1. Mathematics, Paper I. 2. Mathematics, Paper II.
Group II	...	3. Heat Engines. 4. Applied Mechanics. 5. Mechanical Drawing.
Group III	...	6. Building and Civil Engineering Drawing. 7. Surveying.
Group IV	...	8. Chemistry for Engineers. 9. Physics for Engineers. 10. Elecrical Engineering.

Final Examination for the Diploma of Licentiate of the Benares Hindu University in—

(1) Mechanical and Electrical Engineering.

(2) Civil Engineering.

12. The Final Examination for the Diploma of Licentiate in Engineering shall be held once a year, at Benares, at such time and on such dates as the Syndicate may prescribe.

13. No candidate shall be admitted to the above examination, unless he has passed the Preliminary Examination for the Engineering Diplomas or the I.Sc. (Engineering), Part II, of the University, and prosecuted a regular course of study and practice thereafter for not less than two years in the Diploma Course of the Engineering College of the University.

14. A candidate shall apply to the Registrar, in such form as the Syndicate may prescribe. His application and fee shall be despatched through the prescribed channel, so as to reach the Registrar at least thirty days before the commencement of the examination.

15. A candidate who fails to pass, may be re-admitted to a subsequent examination, on a new application and payment of a further fee.

16. For the Licentiate in Mechanical and Electrical Engineering, the subjects of the examination shall be:

(1) Applied Mechanics.
(2) Prime Movers.
(3) Continuous Currents.
(4) Alternating Currents.
(5) Workshop Management.
(6) Drawing.
(7) Design.
(8) Craftsmanship.

17. For the Licentiate in Civil Engineering, the subjects of examination shall be:

(1) Surveying.
(2) Structural Drawing and Design.
(3) Hydraulics, Water-works, Irrigation and Sanitation.
(4) Construction of Roads and Railways and Structures.
(5) Office Routine and Estimates.

18. No candidate shall be allowed to present himself for more than one of the above branches of Engineering in one year, and no candidate may present himself for a second branch until he has obtained his Associateship in the first branch.

19. *The Diploma of Associate of the Benares Hindu University, in*

(1) Mechanical and Electrical Engineering,

or

(2) Civil Engineering

will be awarded to the Licentiate who is able to produce evidence which will satisfy the Syndicate that he has been not less than two years in the successful practice of his profession after obtaining the licentiateship and that he has substantially added to his knowledge and capability. This further experience should preferably be gained in the ordinary pursuit of the profession of Engineering, but study or work within the Engineering College is not barred.

SYLLABUSES.

I.Sc. Part I.

The grouping in the I.Sc., Part I, Course shall be as follows:—

Group I—		
Mathematics (2 papers)	...	100 marks each.
Group II—		
Engineering Chemistry	...	50 marks
and		
Engineering Metallurgy	...	50 marks.
Group III—		
Building		50 marks.
Surveying		50 marks.
Group IV—		
Electrical Engineering (2 papers)		50 marks each.
Group V—		
Applied Mechanics		50 marks.
Heat Engines		50 marks.
Group VI—		
Practical Geometry (1 paper)	...	100 marks.
Mechanical Drawing (1 paper)	...	100 marks.
Total	...	800 marks.
Minimum pass marks per Group	...	40 per cent.
Minimum pass marks on Aggregate	...	40 per cent.

Mathematics.

There will be two papers, each of three hours' duration:—

(1) The first paper will be on Co-ordinate Geometry, Practical Geometry, Differential Calculus and Integral Calculus.

(2) The second paper will be on the remaining portion of the syllabus.

A brief revision of the Inter-Science Syllabus, with a more advanced treatment of certain parts, will precede the following:—

The study of the graphs of the functions ax^n, ae^{bx}, a Sin $(bx+c)$ and of combinations of these. Graphical solution of equations with numerical coefficients. Determination of the equation of a given curve. Slope of a curve. Nomograms, their principle and use.

Co-ordinate Geometry.—Elementary introduction. Cartesian and polar co-ordinates. Equations and properties of the Straight Line, Circle, Parabola, Ellipse and Hyperbola.

Practical Geometry.—Construction of ellipse, hyperbola, parabola, cycloidal curves, involutes, spirals, Envelopes and Similar Curves.

Differential Calculus.—Limits, Differential co-efficients, Rules of differentiation, Geometrical and Mechanical illustrations, Tangents, Normals, Sub-tangents, Sub-normals, Convexity, Concavity, Points of inflexion, Curvature, Radius of curvature, Centre of curvature, Maxima and Minima of one independent variable.

Integral Calculus.—Elementary forms of integration, Definite and Indefinite Integration, Areas, Approximations, Lengths of curves, Surfaces and Volumes of Solids of revolution, Centres of Gravity, Moments of Inertia, Dynamical Applications.

Mechanics.—Displacement, Velocity, and Acceleration: their composition and resolution, Relative Velocity, Projectiles, Mass, Momentum, Force, the Laws of Motion, Motion of simple systems. Work, Power, Energy, Uniform Circular motion, Centripetal and Centrifugal force, Motion in a Vertical Circle, Simple Harmonic Motion, Simple Pendulum, Determination of ' g.'

Resolution and Composition of Forces, Parallel Forces, Moments, Couples.

Equilibrium of forces at a point.

Laws of Friction, Simple Machines with and without friction.

Stable, Unstable and Neutral Equilibrium.

Hydrostatics.—Pressure of a fluid, Transmission of pressures, through a fluid. Pressure on immersed surfaces, Centre of pressure, Condition of equilibrium of a floating body, Archimedes' principle, Specific gravity.

Books recommended:—

Mathematics for Engineers, Vols. I and II, by W. N. Rose.

Differential Calculus by Philips.

Integral Calculus by Philips.

Co-ordinate Geometry by Fawdry.

Mechanics for Engineers by Morley.

Engineering Chemistry.

Introduction.—Definition and Explanation of terms of importance in Chemistry as applied to Engineering Problems and with special reference to the properties, composition and application of materials used by the Engineer.

General Chemistry.—A previous knowledge of Elementary Chemistry is assumed. The Laws of Chemical Composition and Chemical Change, the general properties of gases, vapours and liquids, Oxidation and Reduction, Combustion, Thermochemistry, Dissociation, Electrolysis and Electrolytic action, Acids, Bases and salts. Chemical calculation illustrative of the fundamental principles of chemistry.

Water for Steam Generation.—Good and bad boiler water. Methods of testing the suitability or otherwise of water for purposes of steam generation. Losses and dangers due to the use of unsuitable water. Water softeners and purifiers. Boiler Scale, its prevention and removal.

Fuels.—Classification; Solid, liquid, gaseous; Assay of coal; Manufacture of coke; Spontaneous combustion in Stored coal. Factors governing selection and purchase of Indian Coals. Liquid Fuels. The petroleum products. Gaseous Fuels and gas producers. Sampling and testing of fuels.

Lubricants.—Fundamental requirements. The examination and selection of lubricants. Cooling liquids and lubricants for cutting tools.

Practical Demonstrations.—A short course in fuel and oil testing. Testing of feed water and flue gases.

Engineering Metallurgy.

Introduction.—Definitions and explanation of terms used in Metallurgy. Metals of importance to the Engineer. Their physical and mechanical properties.

General.—Discussion of the nature and objects of metallurgical processes. Chief physical properties of metals and alloys. General properties of fluxes and slags, Refractories.

Iron and Steel.—Pig Iron. The impurities of Pig Iron. Various grades and qualities of Pig, their selection and uses.

Cast Iron and its uses. Methods of producing sound castings. Malleable castings. Foundry work and Pattern making.

Wrought Iron.—Properties and defects of Wrought Iron. Methods of testing, Welding.

Steel.—Classification and methods of manufacture. Properties and defects of Steel. Case Hardening. Methods of testing. Heat treatment and methods of working. Carbon and Alloy Steels. Rusting and Corrosion. Methods of Preservation of Steel and Iron.

Copper.—Properties and methods of working. Useful alloys of Copper and the production of castings.

Aluminium.—Properties and methods of working. The alloys of aluminium and the production of casting.

Other useful Metals.—The chief properties and uses of Zinc, Tin, Lead, Bismuth, Antimony, Nickel and Manganese.

Practical Demonstration—will be given in Foundry Work, Welding and Soldering and in the Testing Laboratory.

Building and Building Materials.

Materials of Construction.—Structure, Classification and characteristic qualities of building stones, preparation of bricks and tiles, cementing materials, concrete, mortar, plasters, paints and varnishes, timber, iron and steel, glass, lead, copper, zinc, and the common alloys; soldering.

Details of Construction (with special reference to Electrical and Mechanical Engineers' requirements).—Selection of site; principles of building design; bearing power of soils; piles and pile driving; kinds of foundation brick and stone masonry; walls; damp-proof courses; floors and roofs of buildings; arches; joints used in woodwork; doors and windows;

wood and iron roof-trusses; staircases; Re-inforced concrete and brick-work; Earthwork; Erection of brick-chimneys for boilers; foundations and machinery fixing; materials for foundations; holding-down bolts and anchor-plates; construction of foundations; vibration; its causes and effects; methods of isolating machinery; fixing of electric motors.

Maintenance and repairs of buildings. Building Regulations. Elementary Sanitation. Artesian Wells.

PRACTICAL WORK.

(1) A brick-field project, from a study of the University brick-field.

(2) Manufacturing Narea Tiles on a potter's wheel.

(3) Putting down bore-holes through soft ground and hard beds.

(4) Ground Tracing of a building from plan.

(5) Drawing of a simple building from measurement.

(6) Estimating quantities and cost of above, and calculating rate per square foot of plinth area.

(7) Schedule of rates of materials and of labour prevailing in the student's district.

Surveying.

Measurement of distances; 100 ft. chain and Gunter's chain; ranging rods and flags; measuring lines on level and sloping ground; obstacles; sources of error in chaining and correction thereof; standardisation of chains.

Conventional signs; applications of geometry, mensuration, and trigonometry; Methods of carrying out a chain survey; tie-lines; offsets; cross-staff and optical square; methods of booking and plotting.

Traverse survey with Prismatic and Surveying compasses; Magnetic North and True North; method of surveying with a compass in the presence of iron; adjustments of closing error in plotting.

Levelling; construction, adjustments and uses of the Dumpy and Y-levels; Abney Level; Level staff; common sources of error in levelling; Datum Line; Bench Marks; methods of booking; plotting level sections; contouring; corrections necessary for the curvature of the Earth and Refraction; flying levels; check levels; reciprocal levelling; Traverse survey with a Transit Theodolite; adjustments of a transit theodolite; measurement of horizontal and vertical angles; taking magnetic bearings with a theodolite; Gale's Traverse system; Tacheometry.

Methods of loose and fast needle surveying with a miner's dial; methods of connecting underground and surface surveys; Surveying with the Plane Table; by magnetic bearings; by the back and forward ray systems; and by Intersection and Interpolation; the "three-point" and "two-point" problems.

Laying out simple Railway Curves by chord and offsets method and by theodolites.

Useful problems.

PRACTICAL WORK.

(1) A course of field work corresponding to the above.

(2) Determination of the Meridian by noting the direction of shadow at apparent noon, and by star observations.

(3) Enlargement, reduction and division of areas.

Electrical Engineering.

Paper I.

Properties of magnets, preparation of magnets, Magnetic Units, Magnetic induction, Magnetic field, Laws of Magnetic force, Intensity of magnetic field and of magnetisation, Magnetic moment, Earth's magnetic field, measurement of permeability by Thompson's Permeameter.

Definition of Electric Units.

Ohm's law and its applications, series and parallel circuits. Kirchhoff's laws and their simple applications.

Specific resistance, Effect of length, cross section, material and temperature on the resistance of conductors.

The measurement of resistance, current and E. M. F.

Heating Effect of Current.—Heating of cables and wires, fuses and their dimensions, Description of carbon and metal filament lamps, Elementary ideas of electric welding, heating and cooking.

Chemical Effect of Current.—Elementary ideas of electroplating and electrometallurgy, Description of dry cells and secondary batteries, both acid and alkaline, their special features and behaviours during charge and discharge.

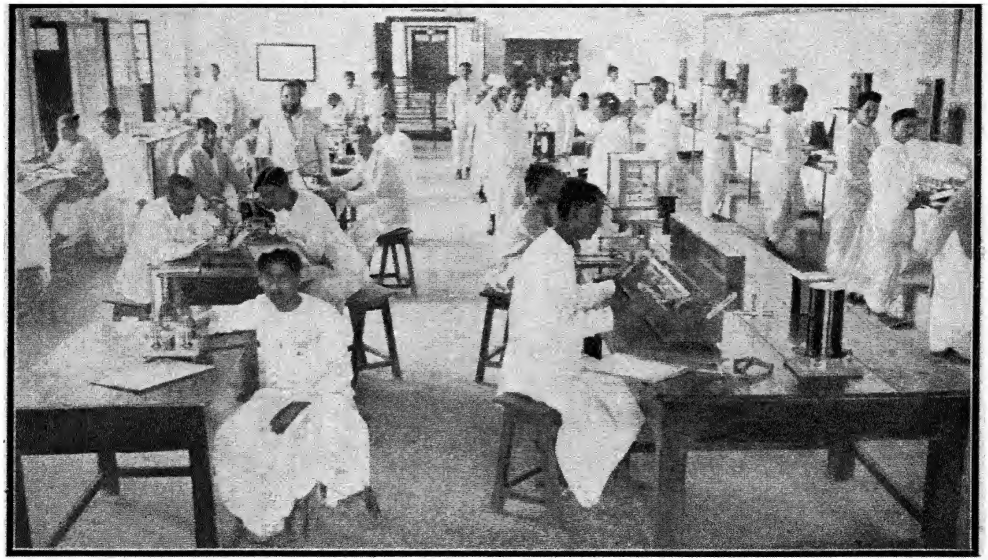
Paper II.

Magnetic Effect of Current.—Field of linear and circular currents. Force between current and magnet poles and between two conductors carrying currents, Solenoids.

Description and uses of ammeter, voltmeter, ohmmeter, wattmeter, typical quantity and energy meters, Kelvin's balance, the Wheatstone Bridge and the Potentiometer.

Principles of Electromagnetic Induction. Description and uses of continuous current dynamos and motors.

Elementary principles of Telephony.



Electrical Engineering Laboratory No. 1.

Books recommended :—

(1) Elements of Applied Electricity by B. C. Chatterjee.

(2) Technical Electricity by David and Hutchinson.

(3) Electrical Engineering Testing by C. D. Aspinall Parr.

List of Experiments to be performed in the Electrical Engineering Laboratory.

(1) Measurements of strengths of magnetic fields and magnetic moments.

(2) Variation of the magnetic field along the axis of a circular coil.

(3) Plotting of B—H curve by Thompson's Permeameter.

(4) Determination of Resistance by Wheatstone Bridge.

(5) Determination of Resistance by drop of potential methods.

(6) Determination of High and Insulation Resistances.

(7) Callibration of Ammeters by Voltmeter.

(8) Callibration of Voltmeters and Ammeters by Comparison.

(9) Standardization of Ballistic Galvanometers.

(10) Measurement of J electrically.

(11) Determination of Fuse constants.

(12) Determination of Temperature rise in windings by the increase of Resistance Methods.

(13) Charging and discharging a Secondary Cell.

(14) Study of Direct Current Generators.

Mechanical Engineering.

(Introductory Course.)

Introduction.—Importance to the Engineer of cultivating from the beginning, the habit of accurate observation and memory. Vague and inaccurate ideas worse than useless. The Engineer's Note Book and how it should be kept.

PART I. HEAT ENGINES.

General Survey of a complete Steam Power Plant and Internal Combustion Power Plant.

The Steam Engine.—Names and functions of all the principal parts of a simple, single-cylinder, non-condensing steam-engine with one eccentric and an ordinary D slide valve. How steam enters and leaves the cylinder and how the admission cut-off release and compression are arranged for. The valve diagram and its application. Materials of which the parts are made and the methods of lubrication.

The Boiler.—Names and functions of all the principal parts of an ordinary Vertical boiler. How steam is raised and maintained, how water is supplied to the boiler and how steam is admitted to or shut off from the engine. The safety-valve, pressure gauge, gauge glass and blow-off cocks. Arrangements for cleaning and inspection. Why the ordinary Vertical Boiler is not efficient. Suggestions for improvement. Circulation, radiation and conduction. Combustion and economy of fuel.

Steam.—Physical properties of steam; the relation between temperature and pressure. Sensible and latent heats. Steam tables and how to use them. Saturated, dry, wet and superheated steam.

Internal Combustion Engine. Names and functions of all the principal parts of a simple oil or gas engine.

PART II. APPLIED MECHANICS.

Force.—Units of force, parallel forces. Parallelogram and triangle of forces. Centres of gravity. Resultant and component forces. Practical applications. Bow's notation applied to simple framed structures. The inclined plane.

Motion.—Speed, velocity, acceleration. Angular velocity and angular acceleration. Mass and momentum. Mass and acceleration. Engineer's units. Simple harmonic motion.

Work.—The diagram of work. The principle of work and its application to simple machines. Friction and efficiency. Friction and lubrication. Joule's equivalent. Work done in the cylinder of a steam engine. Advantage of early cut-off and expansion. Work done by pumps and motors.

Power.—Work done in a given time. The units of power. The indicated horse-power of an engine. Transmission of motion and power by belts and spur gearing. Brake horse-power and mechanical efficiency of an engine. Meaning of the expression "horse-power hour." Pounds of steam and coal per horse-power hour.

Electrical and Mechanical Units.—Units of work, power and supply. The relation between the Mechanical and Electrical units and problems involving a knowledge of that relationship.

Energy.—Definitions and calculations. Potential and Kinetic Energy.

Flywheel and Governor.—The function and operation of each.

Materials.—Stress, strain and modulus of elasticity. Materials in tension, compression and in shear. Elastic limit, yield point and breaking stress. Working stresses and factors of safety. Strength of thin cylinders. Riveted joints. Bending and bending moments.

Materials (contd.).—Modulus of a section and strength of a beam. Twisting and torque. Strength of a shaft subjected to a pure twist. Physical properties and constants of wrought iron, cast iron, mild steel, hard steel, copper and its common alloys.

Hydraulics.—Press, Jack and Accumulator. Reciprocating pumps, suction and delivery. Lift pumps and force pumps. The Pelton wheel.

Books recommended:—

Mechanics of Engineering by L. D. Coueslant.

Steam and Other Engines by J. Duncan.

Practical Solid Geometry.

Pencils, Drawing Instruments and Scales.—How to sharpen pencil points for sketching and for drawing. The use of Drawing Instruments. T Square. Set Squares and Drawing Board. The use of Scales.

Accurate Construction of Scales.—Three-quarters, half, and one-quarter full size, the smallest graduation in each corresponding to $\frac{1}{8}$ of an inch. Diagonal scales to show eighths and sixty-fourths, tenths and hundredths of an inch.

Lettering on Drawing.—For main titles plain block lettering 5×4.

For descriptive notes Italics.

Simple Projection.—Projection of lines, planes, and simple solids.

Advanced Projections and Sections of Solids.—Projections and sections of prisms, pyramids, cylinders, cones, with their axes inclined, and also with the alteration of ground line.

Conic Sections.—Sections of a cone showing the following curves—Ellipse, Parabola and Hyperbola.

Intersections and Interpenetrations.—Intersections, and penetrations of unequal cylinders. A cone penetrated by a Cylinder. Intersection of flat and curved surfaces.

Developments of Surfaces.—Developments of surfaces of cylinders and cones.

Isometric and pictorial projections.

Mechanical Drawing.

Projections and forms of Screw Threads.—The projection of a square-threaded screw, tracing the helix accurately, and a section through the corresponding nut.

The projection of square-threaded screw, multiple threads, marking the lead and pitch distinctly.

The projection of coiled springs, square and round in sections.

Sections of standard forms of various kinds of screw threads. The conventional methods of representing the elevations of various kinds of screw threads.

Standard Details.—Standard forms of rivets, bolts, studs, set screws, and nuts, Keys and key-ways, feathers, Various methods of locking a nut and various kinds of Lubricators.

Sketching and Drawing from the actual machine parts or models.—(1) A stuffing box of a steam engine. (2) The piston. (3) The crosshead. (4) The connecting rod. (5) The eccentric. (6) The D slide valve. (7) A plummer block. (8) A cast-iron flange coupling.

The above details to be sketched proportionately and all the necessary dimensions to be inserted and also the materials, of which the several parts should be made, to be noted down in the Sketch Book, and then from the sketches working drawings to be made.

N.B.—The sketching must be entirely freehand except circles.

To read a Drawing.—Students will be given detailed drawings, showing each part separately and will be asked to make an assembly drawing of the same, showing the over-all dimensions and the dimensions of the principal parts and also will be asked to make detail working drawings from an assembly drawing.

Designs.—Design of simple riveted joints (lap and butt) (*a*) for a tie bar, (*b*) for a boiler.

Design of a cast-iron flange coupling for a shaft. Design of the flange cover and studs for a small steam-engine cylinder. Design for at least one type of stuffing box. Design of a simple bearing for a shaft.

Book recommended:—

Machine Drawing by Jones.

I.Sc., Part II.

The grouping in the I.Sc., Part II, Course shall be as follows:—

Group I—

Mathematics (2 papers)	...	100 marks each.

Group II—

Heat Engines (2 papers)	...	50 marks each.

Group III—

Applied Mechanics (2 papers)	...	50 marks each.

Group IV—

Electrical Engineering (2 papers)		100 marks each.

Group V—

Practical Geometry ...	...	100 marks.
Mechanical Drawing	...	100 marks.
Total	...	800 marks.

Minimum pass marks per Group	40 per cent.
Minimum pass marks on Aggregate	50 per cent.

Mathematics.

There will be two papers, each of three hours' duration :—

(1) The first paper will be on Algebra, Trigonometry, Co-ordinate Geometry, Differential Calculus, Integral Calculus, and Differential Equation.

(2) The second paper will be on Mechanics and Thermodynamics.

Algebra and Trigonometry.—Partial fractions, Complex quantities and their graphical representation. Rules for Addition and Multiplication of vector quantities. De-Moivre's Theorem and Applications, Hyperbolic Functions. Simple test of the Convergence and Divergence of Series.

Co-ordinate Geometry.—Position of a point in space. Direction-cosines of a line. Equations of a Plane, Straight Line, Cylinder, Cone, and Ellipsoid in simplest forms.

Differential Calculus.—Successive Differentiation, Theorem of Leibnitz, Expansions, Taylor's and Maclaurin's Theorems, Partial Differentiation, Asymptotes, Evolutes, Envelopes. Maxima and Minima of two independent variables. Evaluation of Indeterminate forms. Elements of curve-tracing referring to rectangular and polar co-ordinates. Equations and properties of the cycloid, Epi-and Hypo-cycloids, the catenary and spirals. Application to Engineering problems.

Integral Calculus.—Method of substitution. Integration by parts. Integration of Rational Algebraic Fractions. Reduction Formulæ. Successive Integration. Double and Triple Integration. Applications of these in finding Areas. Surfaces Volumes. Centres of Gravity and Moments of Inertia. Fourier's Series and Elements of Harmonic Analyses.

Graphic Integration. Application to Engineering problems.

Differential Equations.—Equations of the First Order. Special types of second order equations. Linear Differential Equations with constant coefficients. Homogeneous Linear Equations. Practical problems involving differential equations.

Mechanics.—Resultants of Force Systems.

Equilibrium of Force Systems.

Frictions—Wedge Screw. Journal Friction. Pivot Friction. Rolling Resistance. Belt Friction.

The Principle of Virtual Work and its application. Centre of Gravity.

Moments and Products of Inertia. Principal axes of inertia. Inertia curves and Momental ellipse. Determination of the principal axes of inertia of unsymmetrical plane figure.

Composition and Resolution of Velocities and Accelerations. Angular Velocity as a vector quantity. Parallelogram of angular velocities and of angular accelerations.

Motion of a particle in a Straight Line and a Plane. Differential equations of Motion. Constrained Motion. Simple Circular Pendulum.

Motion of a Rigid Body. Translation. Rotation. Pressure on the Axis of Rotation. Compound pendulum. Centre of oscillation. Centre of percussion. Combined translation and rotation.

Instantaneous centre. Body and space centrodes. Energy of a body moving in two dimensions. Applications of the Principles of Work and Energy. Impulse and Momentum. Angular Momentum. Angular Momentum as a vector quantity. Applications of the principles of Impulse and Momentum.

Balancing. Need for Balancing. Balancing of Rotating Masses. Introduction to the theory of Spinning Tops and Gyroscopes with Easy Examples. Conical Pendulum and Governors. The Connecting Rod of an Engine.

Thermodynamics.—Thermal Capacities. Heat and Energy. The Kinetic Theory of Gases. Isothermal and Adiabatic Expansion. Ratio of Specific Heats. The Fundamental Equations for a perfect Gas. The Ideal Heat Engine. Reversible Cycles. Carnot's Cycle. The Second Law of Thermodynmics. Carnot's Theorem. Lord Kelvin's Absolute Scale of Temperature. Entropy. Temperature-Entropy Diagrams.

The θ ϕ diagram for water and steam.

Books recommended:—

Co-ordinate Geometry by Fawdry.
Differential Calculus by Philips.
Integral Calculus by Philips.
Differential Calculus by Edwards.
Integral Calculus by Edwards.
Differential Equation by Philips.
Applied Mechanics by D. A. Low.
Applied Mechanics for Engineers by Duncan.
Thermodynamics by Ewing.

Heat Engines.

Steam Power.—General description of a steam plant. The Indicator Diagram and indicated horse-power. Brake horse-power. Absorption and transmission dynamometers. The relation between mechanical and electrical power units. Mechanical efficiency. Thermal efficiency. The laws of Thermodynamics.

Steam Boilers.—The principal types of modern boiler. Cornish and Lancashire Boilers with details of construction and mountings required for their safe working. The Combustion and Economy of Fuel. Chimney Draught. Forced

Draught. Induced Draught. Care and management of boilers. Repair of boilers. Boiler efficiency. Furnace efficiency. Efficiency of transmission. Coal, its composition and calorific value. Liquid fuels. Experimental and analytical determination of calorific values. The adaptation of boilers to different kinds of solid and liquid fuels. Economizers and Superheaters. The feed water and feed pumps. Feed-water Filters. The Injector. Strength of boiler shells. Riveted joints. Strength of gussets, stays, flues, furnaces, domes, and flat surfaces. Steam Pipes. Safety Valves. Openings in boiler shells. Board of Trade Regulations and Lloyd's rules for survey and construction of boilers.

Steam Engines.—Modern forms of steam engine. Cylinders and their fittings. Pistons, Piston Rods and Crossheads. Connecting Rods and Shafting. Guides, Main Frames and Bearings. The Slide Valve and its motion. Valve diagrams. The Valve diagram with corrections for obliquity. The Valve Ellipse. The Bilgram Diagram. The relation between the Valve diagram and the Indicator diagram. The Diagram Factor. Stephenson's link motion. The Meyer Expansion Valve. The principle underlying Radial Valve Gears. The compound Steam Engine. The Combined Diagram. The Triple Expansion Engine. The Condenser, Air Pump, and Circulating Pump. Steam Exhaust and Drain Systems. The Governor and the Flywheel.

Gas and Oil Engines.—Gaseous Fuels. Liquid Fuels. Gas Producer and Vaporisers. Suction Gas Plants. General description of a Gas Engine. Engine bed and cylinder, piston, crank and connecting rod. The Valves and the methods of operating them. The Governor and Flywheel. Ignition systems. Starting arrangements. Cooling water. Pipe connections. Silencer. Lubrication. Foundations. Different systems of Governing.

Carburetters. Vaporisers. Oil Pumps. Different types of Oil Engines. The Four Stroke and the Two Stroke Cycle. Automobile Motors. The Humphrey Gas-Pump.

Applied Mechanics.

Work, Energy, and Power.—Work in lifting, translation and rotation, Work represented by an Area. The Indicator Diagram. The Principle of Work as applied to a Machine. The effect of Friction. The relation between the load, effort, friction and efficiency of a Machine. Curves of Efficiency. The relation between Work, Energy, and Power. Potential and Kinetic Energy. The Kinetic Energy of a Rotating Body. The Flywheel. Power. The relation between Mechanical, Thermal, and Electrical Units of Work, Power and Energy. Loss of Power at Bearings and Journals. Power and Efficiency of Engines, Pumps, Motors, and Dynamos. Dynamics of the Steam Engine.

Force, Mass, and Motion.—Velocity and Acceleration. Relations of Force, Mass and Motion. Engineer's Units. Impulsive forces. Angular Velocity and Acceleration. Angular momentum. Simple Harmonic Motion. Centrifugal Force. Balancing. Governors. Graphical Solution of Problems. Velocity and Acceleration Diagrams.

Force.—The Engineer's idea of Force. The measurement of Force. Resolution of Forces. Moments of Forces. Some practical applications of Forces and Moments. Graphics. Forces represented by lines. Bow's Notation. Forces in Framed Structures. The Funicular Polygon. Moments and Shearing Force Diagrams.

Friction and Lubrication.—Laws, experiments and results. Relation between the Forces acting on a Sliding Body. Efficiency of the Inclined Plane, and Screw. Friction of Pivots and Collars. Schieles' Pivot. Tower's Experiments. Friction of an Axle. Friction Axis of a Link. Work lost in Friction in Journal Bearings.

Methods of Lubricating Bearings. Pad, bath, ring and splash lubricator. Goodman's Experiments. Rolling Friction. Ball bearings. Roller bearings.

Transmission of Motion and Power.—Belts, Ropes and Spur Gearing. Wheel Trains. Mechanisms peculiar to Lathes, Milling Machines, Planing and Slotting Machines. Bicycles and Motor Cars.

Strength and Elasticity of Materials.—Simple Strains and Stresses. Beams and Bending. Deflection of Beams. Columns and Struts. Behaviour of Materials in the Testing Machines. Torsion of Shafts.

Hydraulics.—Pressure on an immersed surface, buoyancy, density. Hydraulic Press and Jack. Hydraulic Accumulators, Lifts and Cranes. Suction Single and Double Acting Force Pumps. Flow of water through orifices, pipes, and channels. Water Wheel, Centrifugal Pumps, and Turbines.

Electrical Engineering.

Paper I.

Magnetic Properties of Materials.—Magnetic quality of iron. Residual Magnetism, Permeability, Laws of magnetic circuit and calculation thereon. Hysteresis.

Electric Properties of Materials.—Conductors and Insulators. Insulating Materials. The Insulation of Wires and Cables. The effect of moisture and heat on conductors and insulators. Eddy current losses.

Battery.—Setting up a Secondary Battery. Management of a Secondary Battery. Its care and daily attendance.

Dynamo Electric Machines.—Physical principle, essential parts, operation and uses of both Generators and Motors. Continuous-current Dynamo Electric Machine. Series, Shunt and Compound Winding. Starting and Regulating Appliances.

The Magnetic Field of Dynamo Electric Machines, Relation of torque, speed and H. P., different types of load and speed control of motor. Efficiency and characteristics of Generators and Motors and their Experimental Determination and Calculation.

Inspection, erection and management of Dynamo Electric Machine.

Paper II.

Elements of Alternate Current.—Graphical representation of a current, voltage and power in A. C. circuits. Frequency, phase and effective value of current and voltage.

Alternators, their principles, operation and uses. Star and mesh connections. Simple A. C. circuits, power-factor, self-inductance, choke coils, Capacitance and Impedance.

Electric Lighting.—Main switch, switchboard, distributing boards, and branch switch. Main cut-outs and fuse-board. Arc lamps, Mechanisms and principles involved in their use and testing. Ceiling-roses and wall-plugs. Incandescent lamps, their life, efficiency and cost. Pendants, Electroliers, wall-brackets and general fitting cables, casing running the wires. Arranging the circuits. Proper size of wires for a given number of lamps. Testing the wiring, electric fittings. Wiring Rules and Regulations. Private Installation Work.

Books recommended:—

(1) Elements of Applied Electricity, Vol. II, by B. C. Chatterjee.

(2) Continuous Current Electrical Engineering by W. T. MacCall.

(3) Alternate Current Electrical Engineering by W. T. MacCall.

List of Experiments to be performed in the Electrical Engineering Laboratory.

(1) Measurement of Magnetic Permeability by Ewing's Permeability Bridge.

(2) Measurement of Permeability and Hysteresis of Magnetic Materials by Ballistic Method.

(3) Measurement of Capacity of Condensers.

(4) Insulation tests of Cables.

(5) Insulation tests of Electrical Machines.

(6) Relation between speed and voltage of separately excited dynamos.

(7) Magnetisation curves of dynamos at no-load.

(8) External characteristic curves of separately excited dynamos.

(9) External characteristic curves of shunt dynamos.

(10) Speed Variation of D. C. motors with impressed voltage.

(11) Speed Variation of D. C. motors with excitation.

(12) Measurement of self-inductance.

(13) Experimental study of circuits containing resistance inductance, and capacity in series and in parallel.

(14) Study of a storage battery, charging and discharging.

(15) Determination of the energy consumption of a glow lamp, its candle power and efficiency.

(16) Jointing of Cables.

Practical Geometry.

Geometrical Mechanisms.—Cams and toothed wheels. Valve diagrams. Velocity and acceleration diagrams. Piston and crank effort diagrams. Link motion diagrams.

Graphic Statics.—Graphical representation of forces. The link polygon and its applications, Graphical representation of Moments and Couples and problems relating thereto.

Framed Structures.—Roofs and Roof Trusses, Braced Cantilevers, Beams and Girders. Determination of Stresses due to Dead Load and to Wind Pressure.

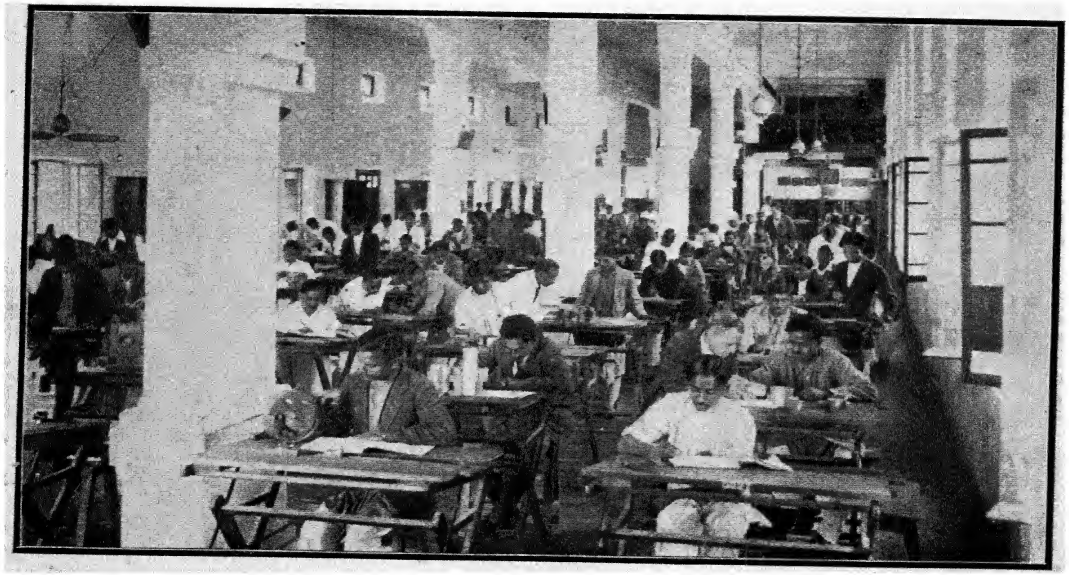
Beams.—Bending Moment and Shearing Force Diagrams, Moments of Inertia of Cross-sections. Reinforced Concrete Section. Simple problems on Rolling Loads.

Mechanical Drawing.

Introduction.—Strength and nature of materials used in Machine Construction. Strains and Stresses. Elasticity and Elastic Limit. Effect of Live Loads. Factor of Safety. Cast Iron, Steel, Varieties of Steel. Case Hardening. Tempering and Heat Treatment of Steel. Copper, Alloys of Copper. Bronze or Gun-Metal, Phosphor-Bronze. Manganese-Bronze, Brass. Muntz Metal. Naval Brass. "White" Metals. Wood.

Machine and Engine Details.—Preparation of complete working drawings and specifications, from sketches and notes obtained by actual observation, investigation and measurement of details.

Study of proportion in machine details, by observation, calculation, and measurement. Keys and Cotters. Pipes and Pipe Joints. Shafting and Shaft Couplings. Pedestals and Plummer Blocks. Hanger Brackets. Wall Boxes and Footsteps. Countershafts. Pulleys and Speed Cones. Spur and Bevel Gears. Lubricators. Cranks. Crank Shafts and Eccentrics. Piston and Piston Rods. Cross-Heads and Guides. Connecting Rods. Stuffing Boxes. Valves, Valve Rods, Eccentric Rods and Links.



MECHANICAL DRAWING CLASS.

Steam Boilers.—Iron and Steel suitable for boiler construction. Strength of Cylindrical Boiler Shells. Cylindrical Furnaces. Modern Furnaces for high pressures. Resistance to collapse. Experiments by Lloyd's Registry and the Board of Trade. The Fox, Purves, Morrison and Deighton Furnace. Flat Surfaces. Bolts and Stays. Diagonal Stays. Palm Stays and Gussets. Tube Plates. Tubes. Stay Tubes. Grate Area and Heating Surface, and steam per lb. of coal. Openings in Boiler Shells. Steam Domes, Manholes and Doors. Riveting. Zig-zag riveted and Chain riveted Joints. Single, Double, and Treble riveted Lap and Butt Joints. Efficiency of Riveted Joints, Graphical methods of design. Lever, Dead Weight, and Spring Loaded Safety Valves. Steam Pipes and Stop Valves. Feed Pipes, Economisers, Filters and Feed Pumps.

Simple Steam Engine.—Determination of the general dimensions for a simple, single cylinder, steam engine, given the Indicated Horse-power, Speed and Boiler Pressure.

Finished Drawing.—Students are expected to prepare, from their own sketches and notes, complete working drawings and specifications of some simple type of boiler with all its mountings and fittings, and also of a single-cylinder steam engine. The engine may be horizontal or vertical type, but all the dimensions must be carefully calculated, and the calculations handed in with the drawing. If the sketches used are from an existing steam engine, the dimension must be checked and compared with those obtained by calculation.

Tracing and Blue Print.—All drawings will, in the first instance, be neatly and accurately finished in pencil. These pencil drawings will be traced by the student and blue print taken on Ferropaper prepared by the student himself.

Note Book.—Great importance is attached to the student's sketch-book in this class. It will be examined periodically, and marks awarded. No drawing will be considered if the corresponding sketches are not found, together with other necessary particulars, in the student's own note book.

B.Sc., Part I.

The grouping in the B.Sc., Part I, Course shall be as follows:—

Group.	Subject.	Nature of Examination.	Full Marks.	Pass Marks.
I.	Strength of Materials	Written 3 hours ...	100	
	Theory of Structures	,, ,, ...	100	
	Structural Design ...	Sessional work ...	100	60
II.	Theory of Machines ...	Written 3 hours ...	100	
	Hydraulics ...	,, ,, ...	100	
	Mechanical Drawing	Sessional work ...	100	60
III.	Heat Engines ...	Written 3 hours ...	100	
	Engine Design ...	Sessional work ...	100	60
IV.	Electrical Engineering, Paper I ...	Written 3 hours ...	100	
	Electrical Engineering, Paper II ...	,, ,, ...	100	
	Design of Electrical Machines ...	Sessional work ...	100	60
	Design of Electrical Installations ...	Sessional work ...	100	60
		Total ...	1,200	marks.

Minimum pass marks for Sessional work ...	60	per cent.
,, ,, ,, per Group ...	40	,, ,,
,, ,, ,, on Aggregate ...	50	,, ,,
,, ,, ,, for Second Class ...	60	,, ,,
,, ,, ,, ,, First Class ...	70	,, ,,

Strength of Materials.

Testing machines and instruments. Elastic and plastic stresses; Resilience; Overload; Dynamic stress; Fatigue. Deflection and slope of cantilevers, and girders; Graphical methods for Deflection. Thick Cylinders; Tube Guns. Springs. Struts. The Elastic Constants. Principal stresses. Rankine's Equivalent Twisting Moment. Oscillations of Elastic Systems. (Elementary) Flat Plates. (Bach's methods.)

Theory of Structures.

Complete study and design of a Roof Truss. Frames with members subject to Bending. Suspension Structures under Dead Loads. The Three-hinged Arch. Encastic Beams. Complete study and design of the Plate Girder with Dead and Live Loads. Masonry. Reinforced Concrete Beams and Columns. Gravity Dams and Retaining Walls. Introduction to Influence. Line methods. Introduction to the methods of Test Work.

Theory of Machines.

Standard methods for velocity and acceleration; application to the Steam Engine. Turning effort diagrams. Flywheels and Governors. Tooth wheel's strength, and general principles for correct profile of teeth. The Involute Tooth. Elements of Gear-cutting. Belt and Rope Driving. Brakes and Clutches. Epicyclic Gears. Simple Skew Gears. Primary Balancing. Cams.

Hydraulics.

Water at rest (including simple problems on stability of Floating Bodies). Fluid Friction. Benoulli's Law corrected for Friction. Channels, Small Orifices. Notches and Weirs; the Standard Formulæ. Intensifiers and Accumulators. Water Meters. Pump and Pumping. The Reciprocating Pump. The Centrifugal Pump. The Pelton Wheel.

Heat Engines.

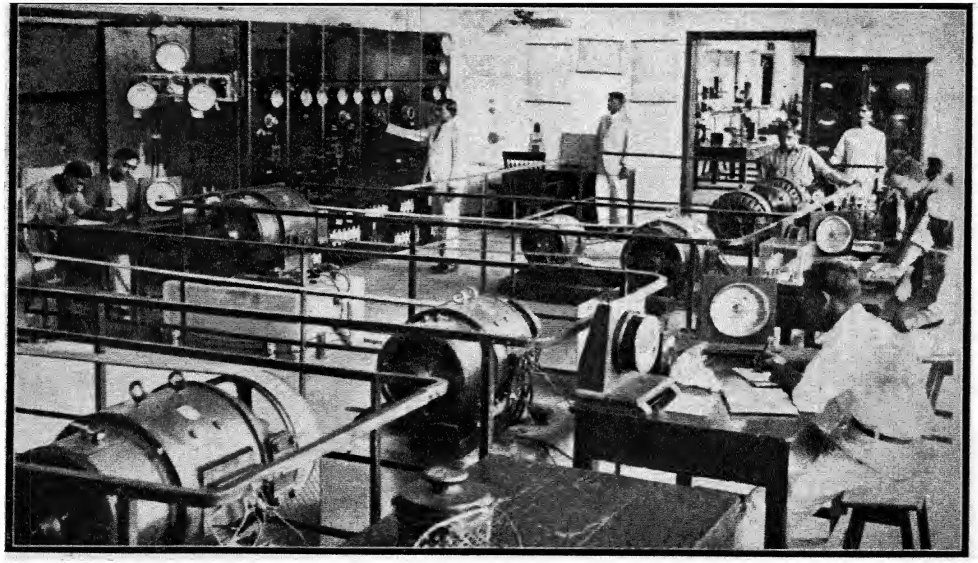
Valve Gears from the Designer's point of view. Meyer Expansion Gear. Radial Gears. Drop Valves and Valve Gears. Compounding. The Entropy temperature chart in Design. Nozzles. Pressure compounded, and velocity compounded Turbines. Turbine Details. Turbine Governors. Main dimensions of the Internal Combustion Engine. Carburation. Ignition. Valve Timing and Cam Design. Principle, and peculiar features of the Diesel Engine. The Suction Gas Producer.

Electrical Engineering.

Paper I.

Principles and details of designs, construction and calibration of switchboard and laboratory instruments.—Action of measuring instruments. Deflecting and controlling forces, friction, dead-beatness and damping force. Type of D. C. and A. C. ammeters, voltmeters, wattmeters, frequency meters, synchroscope, power-factor meter. Methods of alternating range of ammeters and voltmeters, switches, principles and details of construction and general discussion of switchboards, and the arrangement of busbars, testing of switchboards, measuring, controlling and protective devices.

Elementary mathematical treatment of Alternate Current.



ELECTRICAL ENGINEERING LABORATORY NO. 2.

Books recommended:—

(1) Elements of Applied Electricity, Vol. III, by B. C. Chatterjee.

(2) Dynamo and Motor Control by Ibbetson.

(3) Electrical Engineering Practice in India by J. W. Meares and Neale.

(4) Economics of Engineering by Coueslant and Chatterjee.

(5) Electrical Engineering by Thomalen.

(6) Electrical Engineering Testing by Aspenall Parr.

(7) Dynamo Testing by C. F. Smith.

(8) Alternator Testing by C. F. Smith.

(9) Testing of Electro-magnetic Machinery (2 vols.) by Swenson and Frankenfield.

(10) Electrical Machine Design by Alexander Gray.

List of Experiments to be performed in the Electrical Engineering Laboratory.

(1) Calibration and Standardisation of Ammeters.

(2) ,, ,, ,, ,, Voltmeters.

(3) ,, ,, ,, ,, Watt-hour-meters.

(4) Further Photometric tests on glow and arc lamps.

(5) Efficiency and other tests on Secondary Cells.

(6) Localisation of Faults in Electric Light Mains.

(7) Determination of Characteristics, Regulation and Percentage of Over-compounding of D. C. Generators.

(8) Determination of Characteristics and Regulation of Single and Polyphase Alternators.

(9) Parallel Operation of D. C. Generators.

(10) Measurement of Iron and Friction Losses in D. C. Machines.

(11) Efficiency tests on D. C. Generators and Motors.

(12) Measurements of Power Factor in Single and Polyphase Circuits.

(13) Operation of different types of A. C. Motors and their no-load tests.

(14) Determination of Regulation of Transformers.

(15) Measurement of Core Losses in Transformers.

(16) Armature Winding.

B.Sc., Part II.

The grouping in the B.Sc., Part II, Course shall be as follows:—

Group.	Subject.	Nature of Examination.	Full Marks.	Pass Marks.
I.	Properties of Materials	Written 3 hours.	100	
	Theory of Structures	,, ,,	100	
	Structural Design ...	Sessional work ...	100	60
II.	Hydraulics ...	Written 3 hours.	100	
	Hydro-electric Technology ...	,, ,,	100	
	Machine and Engine Design ...	Sessional work ...	100	60
III.	Heat Engines ...	Written 3 hours.	100	
	Electrical Engineering, A. ...	,, ,,	100	
	Electrical Engineering, B. ...	,, ,,	100	
	Design of Electric Installation ...	Sessional work ...	100	60
IV.	Business method ...	Written 3 hours.	100	
	Workshop Management	,, ,,	100	
	Craftsmanship (or approved extramural practice) ...	Sessional work ...	200	120
		Total ...	1,400	marks.

Minimum pass marks	for Sessional work	...	60 per cent.
,, ,, ,,	per Group	...	40 ,, ,,
,, ,, ,,	on Aggregate	...	50 ,, ,,
,, ,, ,,	for Second Class	...	60 ,, ,,
,, ,, ,,	for First Class	...	70 ,, ,,

Properties of Materials.

Complex states of stress. Theories of Elastic Failure. Wire-wound Guns. Helical springs of large Pitch. Cone springs. Carriage springs. Clock springs. Beams not originally straight. Crane Hooks. Beams of unsymmetrical cross section. Whirling shafts. Excentrically and laterally loaded struts. Theory of three moments. Elements of Heat Treatment of Steel. Magnetic and electric properties of metals. This is in addition to the work of preceding years. Developments of importance as recorded in the Engineering Journals are never excluded from fourth year syllabuses.

Theory of Structures.

Deficient and Redundant Frames in Two and Three Dimensions. Theory of Least Work applied to Redundant Frames. The method of stress coefficients in two and three dimensions. Deflection of Frames. Suspension structure with Live Loads. Live Loads on Framed Structures. The Two-hinged and Hingeless Elastic Arch. Portals and Wind Bearing. Secondary Stresses. Swing Bridges. See note appended to previous syllabus.

Hydraulics.

Wells and well sinking; Tube wells. Multiple Impeller Centrifugal Pumps; Balancing; Friction Losses; Speed, Head, and Efficiency. Acceleration in the Reciprocating Pump Vortices. Viscous Flow, and Critical Velocity. Pipe Line Problems. Turbines. Specific speeds. The Pelton Francis and Propeller Turbine. Governing of Turbines. Water Hammer. Stand Pipes. Surge Tanks. Students of this subject in this class are expected to have read any outstanding article on Hydro-Electric Development appearing in the Technical Press during the current session.

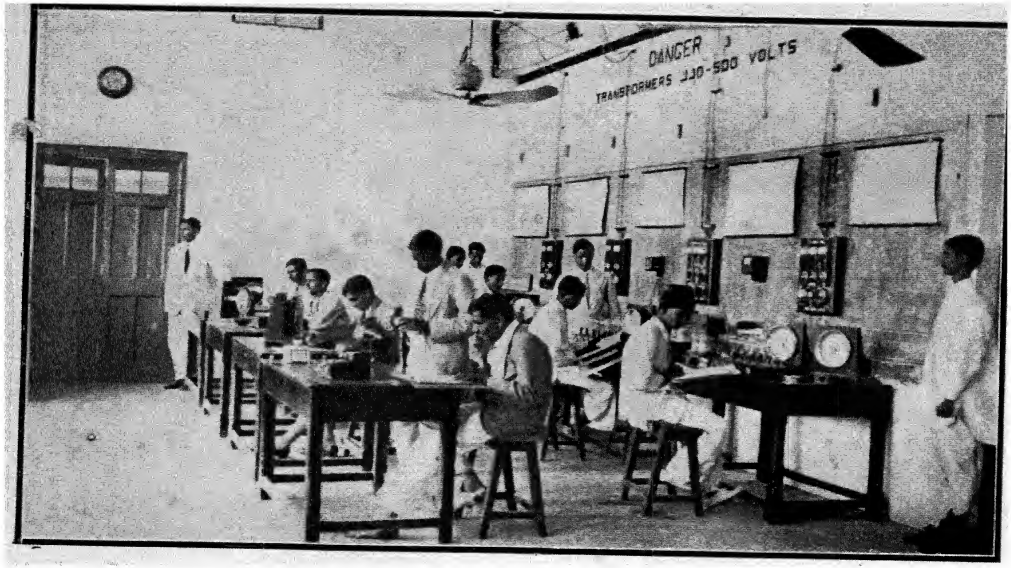
Hydro-Electric Technology.

1. Characteristics of a suitable Water Supply. Conservation of Water Power Storage Reservoirs, and Dams. Gravity and Arch Dams. Disposal of Storm Water. Spillways. River Gauging. Pipe Lines. Power House Topography. Stand Pipes. Surge Tanks. Choice of a Turbine. Governing. Water Hammer, and Air Problems. High Tension Generation and Long Distance Transmission. Linking up and Conversion. Combinations of Steam and Hydro-Electric Generation. Economics of Hydro-Electric Power Supply. Recent Developments.

2. Laboratory and Power House Duty. Students are withdrawn from the workshop in small groups of from two to a dozen members for Testing of Materials. Engine and Boiler Testing and Power Plant Supervision. Laboratory Practice in the Third and Fourth Year is a Workshop subject.

Theory of Heat Engines.

Fundamental Thermo-Dynamic Principles and Formulæ. Specific Heats. Throttling at constant H. Standard cycles. Callendar's Equations and tables for steam nozzles. Injectors. Heat Diagrams. Condition Curves. Properties of NH_3 and CO_2. Absorption Refrigerators. Air Compressors. Compression Refrigerators. Condenser, and air pump. Cooling Towers. Accumulators and other accessories. As there have been regular lectures on Heat Engines for the preceding three years, the tendency of this class will be to a more thorough examination of fundamental principles.



Electrical Engineering Laboratory No. 3.

Electrical Engineering.

Paper A.

Special Machines.—Elementary principle, operation and uses of Balancers and Boosters; Phase advancers, Frequency changers, Induction regulators, Rotary and Motor converters, Transverters, Tork motors, Mercury arc rectifiers, Valves, Electrolytic rectifiers, etc.

Electric Lighting.—General principles of lighting, Standards of value in lighting. Determination of candle-power required for illumination, lighting of rooms and streets, factors of the cost of lighting. Lighting, public and private. Busbars, Feeders, Distributors and Internal wiring.

Continuous and Alternating Current Circuits.—Influence of resistance, capacity and self-inductance, resonance, free and damped oscillations. Lighting Protection. Protection against Disruptive Discharges.

Paper B.

Transmission.—Design and value of high tension and long distance transmission lines. Details of Erection, Construction, Testing and Maintenance. Safety Devices, Limitation of Voltage. Feeders and distributing mains. Substations, choice of positions, plant, general arrangement. Graphical and Mathematical solutions of A. C. long distance transmission.

Distribution.—Medium and Low voltage distribution systems, Mechanism of distribution for a public supply. Consumer's circuit and connections, Motors and Plants. Requirements to be satisfied by insulated conductors used in distribution as regards voltage regulations, the three-wire system.

Localization and remedy of troubles in dynamo-electric machines and electric circuit.

Electric Traction.—Electric traction by continuous alternate current. Principles and details of systems of Tramway and Railway Engineering ordinarily used. Permanent feeders. Surface and conduit systems. Collection and control current.

Sessional Work.—Design of Electric Installations.

List of Experiments to be performed in the Electrical Engineering Laboratory.

(1) Standardisation of Wattmeters.

(2) Callibration and other tests on different types of Meters.

(3) Further tests on the localisation of Faults in Electric Light Mains.

(4) Further tests on Efficiency of Direct and Alternate Current Generators.

(5) Load tests on different types of D. C. and A. C. Motors.

(6) Efficiency B. H. P. and Regulation of Direct and Alternate Current Motors.

(7) Determination of Characteristics and Efficiency of Synchronous Converters.

(8) Determination of Characteristics and Efficiency of Inverted Rotaries.

(9) Circle diagrams of Induction Motors.

(10) Circle diagrams of Repulsion Motors.

(11) Miscellaneous tests on Synchronous Motors.

(12) Parallel Operation of Single and Polyphase Alternators.

(13) Miscellaneous tests on Motor Generators.

(14) Miscellaneous tests on separately excited Boosters.

(15) Insulation tests of Electrical Machines and Installations while working.

(16) Efficiency and other tests on Transformers and their Parallel Operations.

(17) Performance tests of Electrical Machines.

(18) Influence of the Power Factor of the Load on the Voltage Regulation of Transmission Lines.

(19) Determination of the Periodic E.M.F. and Current Curves of Alternators.

(20) Dielectric tests with High Tension Transformers.

Business Method.

Money, Capital, and Credit. Banks and Insurance Companies. Company Law. Trading abroad. Transport, Exchange. Principles of Book-keeping. Office Routine. Filing systems. Correspondence. Speculation and Investment.

Workshop Management.

Choice of Site, Building, Plane. Choice of a Prime Mover, Jobbing and Mass Production. Progress Cards. Workmen's Time Cards. Machine cards. Stores. Stock taking and valuation. Raw materials costs. Gate control. Theory of overtime. Overhead charges. Limits. Jigs. Gauges and Fixtures. Speeds and Feeds. Industrial Laws. Payment by Results. Principles of Mass Production. Patents and Registered Trade Marks.

Sessional Work.

The ground to be covered in a full Engineering Course is so extensive that thorough treatment is impossible. Only fundamental principles can be indicated, and the problems solved here and there which present special difficulty.

It is, however, an accumulation of carefully designed small details that principally distinguishes a trustworthy machine or structure from an untrustworthy one. In order to drive home this important fact, two or three machines, structures or installations are selected each year for intensive study. The students are required to produce working drawings throughout the session, and submit them for examination at the end. In this work it is the details that matter. None is too small to be the subject of a thorough search and much thought, which must be embodied in fully dimensioned working drawings.

Preliminary Diploma.

The grouping in the Preliminary Diploma Course shall be as follows:—

Group I ...	Mathematics, Paper I	...	100 marks.
	Mathematics, Paper II	...	100 ,,
Group II ...	Heat Engines ...	...	100 ,,
	Applied Mechanics	...	100 ,,
	Mechanical Drawing	...	100 ,,
Group III ...	Building and Civil Engineering Drawing ...	...	100 ,,
	Surveying ...	...	100 ,,
Group IV ...	Chemistry for Engineers	...	100 ,,
	Physics for Engineers	...	100 ,,
	Electrical Engineering	...	100 ,,
	Total	...	1,000 ,,

Minimum pass marks per Group		...	40 per cent.
,, ,, ,,	on Aggregate	...	60 ,, ,,
,, ,, ,,	for Second Class	...	70 ,, ,,
,, ,, ,,	,, First Class	...	80 ,, ,,

Mathematics.

There will be two papers, each of three hours' duration:

(*i*) The first paper will be on Algebra and Trigonometry.

(*ii*) The second paper will be on Mensuration, Differential Calculus and Integral Calculus.

Algebra.—Simple and simultaneous equations. Indices, Surds and Logarithms. Common Logarithms. Use of Logarithms in making calculations. The Slide Rule and its use.

Quadratic Equations.

Arithmetic, geometric and harmonic progression. Simplification and partial fractions. Napierian Logarithms. Harder exercises in logarithms. Manipulation and evaluation of complicated engineering formulæ. Theory of quardratic equations. Permutations and combinations. The binomial theorem and its applications. Coordinates. The plotting of points and the construction of simple graphs.

Determination of simple laws connecting two variables representing experimental Data. Graphical solution of equations. Nomograms. Equations of straight line, circle, parabola, ellipse and hyperbola in simplest forms.

Trigonometry.—Trigonometrical ratios of angles. Use of trigonometrical tables and of slide rules. Graphs of trigonometrical functions. Simple relations between trigonometrical ratios. Trigonometrical ratios of the sum, and difference of angles and of multiples of an angle. Problems on Heights and Distances. Solution of triangles. Solution of trigonometrical equations. Hyperbolic functions. Inverse trigonometrical functions.

Mensuration.—Areas of plane figures. Mean ordinate and Simpson's Rule for areas.

Mensuration of the simpler solid figures, the sphere, the cylinder, the pyramid and the cone. Guldinus's Theorem.

Differential Calculus.—Definition of a differential coefficient. Differentiation of functions of one independent variable. Geometrical and Mechanical Illustrations. Application of the calculus to the determination of maxima and minima, velocity and acceleration. Curvature and radius of curvature.

Integral Calculus.—Elementary forms of Integration. Determination of areas, volumes, centres of gravity and moments of inertia. Dynamical Applications. Graphic Integration.

Book recommended:—

Manual of Practical Mathematics by Frank Castle.

Heat Engines.

General plan of a Steam Engine Plant. Boilers. Boiler mountings. Chimneys and Flues. Draught. The simple Steam Engine, its management and its details. Valves and valve diagrams. Materials. Lubrication. Flywheels and Governors. Condensers, air pumps. Feed pumps, Economisers. Feed heaters and superheaters. Compound Steam Engines. Fundamental Laws of Thermodynamics. Carnot and other cycles. Properties of the perfect gas. Simple air compressors. The Internal Combustion Engine. Constant pressure and constant volume. Two and four stroke cycles. Ignition and Carburation. Details of the I. C. Engine. Properties of steam. Entropy. Rankine's cycle. Steam Calorimetry. Refrigeration and Refrigerating machines.

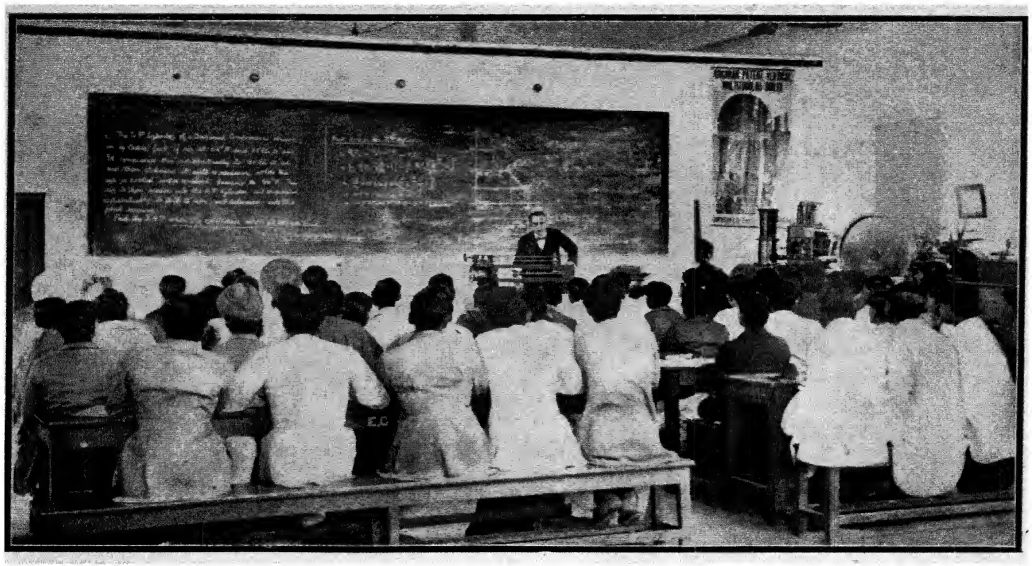
Books recommended:—

Heat Engines by D. A. Low.

Heat Engines by L. D. Coueslant.

Applied Mechanics.

Energy, work, power and force. Graphical representation. Newton's Laws. Mass and Momentum. Linear and angular motion. The polygon of forces. The inclined plane and screw. The Flywheel. Simple harmonic motion. Watt's and Porter Governor. Friction and Lubrication. Lubricators. Forced lubrication. Physical properties of the usual materials. Stress Strain and Elasticity. Working stresses and factors of safety. Thin Cylinders. Riveted Joints. Frames. Bow's notation. The funicular polygon and its application. Bending moment and shearing force diagrams. Moments of Resistance, and Modulii of Sections. Simple deflection of beams. Torsion and transmission of power by shafting. Belts and pulleys. Toothed wheels. The simple machine.



ENGINEERING CLASS ROOM.

Hydrostatics. Total pressure and centre of pressure. Law of Archimedes. Bernoulli's Law. Simple Orifices. The hydraulic press and hydraulic jack. Pumps. The Pelton Wheel.

Book recommended:—

Engineering Mechanics by L. D. Coueslant.

Mechanical Drawing.

Care of Instruments. Construction of scales. Lettering. Free-hand sketching. Projections. Intersections and Interpenetrations. Important Curves. Development of surfaces. Projection of screws and helical springs. Standard screw threads, rivets, bolts, studs, nuts, keys and keyways. Engine Details. Boiler Details. Riveted Joints. Valves and Cocks. Details of Power Transmission Shafts, Pulleys, Belts, Toothed Wheels, Bearings. Engine and machine details to be drawn as if for manufacture, due consideration being given to the requirements of the pattern-maker, smith, and Machinemen. Tracing. Blue and other prints.

Building and Civil Engineering Drawing.

Materials of Construction.—Structure, classification and characteristic qualities of building stones, preparation of bricks and tiles, cementing materials, concrete, mortar, plasters, paints and varnishes, timber, iron and steel, glass, lead, copper, zinc, and the common alloys; soldering.

Details of Construction.—Selection of site; principles of building design; bearing power of soils; piles and pile driving; kinds of foundation; brick and stone masonry; walls; damp-proof courses; floors and roofs of buildings; arches; joints

used in woodwork; doors and windows; wood and iron roof-trusses; staircases; re-inforced concrete and brick-work; earthwork; erection of brick-chimneys for boilers; foundations and machinery fixing; materials for foundations; holding-down bolts and anchor-plates; construction of foundations; vibration; its causes and effects; methods of isolating machinery; fixing of electric motors.

Maintenance and Repairs of Buildings; Building Regulations. Elementary Sanitation. Artesian Wells.

PRACTICAL WORK.

(1) A brick-field project, from a study of the University brickfield.

(2) Manufacturing Narea Tiles on a potter's wheel.

(3) Putting down bore-holes through soft ground and hard beds.

(4) Ground tracing of a building from plan.

(5) Drawing of a simple building from measurement.

(6) Estimating quantities and cost of above, and calculating rate per square foot of plinth area.

(7) Schedule of rates of materials and of labour prevailing in the student's district.

Books recommended:—

Notes on Buildings and Building Materials by B. C. Chatterjee.

Surveying.

Measurement of distances; 100′ chain and Gunter's chain; ranging rods and flags; measuring lines on level and sloping ground; obstacles; sources of error in chaining and correction thereof; standardisation of chains.

Conventional signs; applications of geometry, mensuration, and trigonometry; methods of carrying out a chain survey; tie-lines; offsets; cross-staff and optical square; methods of booking and plotting.

Traverse survey with Prismatic and Surveying compasses; Magnetic North and True North; method of surveying with a compass in the presence of iron; adjustments of closing error in plotting.

Levelling; construction, adjustments and uses of the Dumpy and Y Levels; Abney Level; Level Staff; common sources of error in levelling; Datum Line; Bench Marks; methods of booking; plotting level sections; contouring; corrections necessary for the curvature of the Earth and Refraction; flying levels; check levels; reciprocal levelling; Traverse Survey with a Transit Theodolite; adjustments of a transit theodolite; measurement of horizontal and vertical angles; taking magnetic bearings with a theodolite; Gale's Traverse System; Tacheometry.

Methods of loose and fast needle surveying with a miner's dial; methods of connecting underground and surface surveys; Surveying with the plane table; by magnetic bearings; by the back and forward ray systems; and by intersection and interpolation; the "three-point" and "two-point" problems.

Laying out simple Railway Curves by chord and offsets method and by theodolites.

Useful problems.

PRACTICAL WORK.

(1) A course of field work corresponding to the above.

(2) Determination of the Meridian by noting the direction of shadow at apparent noon, and by star observations.

(3) Enlargement, reduction and division of areas.

Book recommended:—

Class Notes on Surveying by H. K. Sen.

Chemistry for Engineers.

CHEMISTRY:

Introduction.—Definition and explanation of terms of importance in Chemistry as applied to Engineering Problems and with special reference to the properties, composition and application of materials used by the Engineer.

General Chemistry.—Elementary Chemistry; the Laws of Chemical Composition and Chemical Change; the general properties of gases, vapours and liquids; Oxidation and Reduction, Combustion, Thermo-chemistry, Dissociation, Electrolysis and Electrolytic action; Acids, Bases and Salts. Chemical calculation illustrative of the fundamental principles of chemistry.

Water for Steam Generation.—Good and bad boiler water. Methods of testing the suitability or otherwise of water for purposes of steam generation. Losses and dangers due to the use of unsuitable water. Water softeners and purifiers. Boiler Scale, its prevention and removal.

Fuels.—Classification; Solid, liquid, gaseous; Assay of coal; Manufacture of coke; Spontaneous combustion in stored coal. Factors governing selection and purchase of Indian Coals. Liquid Fuels. The petroleum products. Gaseous fuels and gas producers. Sampling and testing of fuels.

Lubricants.—Fundamental requirements. The examination and selection of lubricants. Cooling liquids and lubricants for cutting tools.

Practical Demonstrations.—A short course in fuel and oil testing. Testing of feed water and flue gases.

METALLURGY:

Introduction.—Definitions and explanation of terms used in Metallurgy. Metals of importance to the Engineer. Their physical and mechanical properties.

General.—Discussion of the nature and objects of metallurgical processes. Chief physical properties of metals and alloys. General properties of fluxes and slags. Refractories.

Iron and Steel.—Pig Iron. The impurities of Pig Iron. Various grades and qualities of Pig, their selection and uses. *Cast Iron* and its uses. Methods of producing sound castings. Malleable castings. Foundry work and Pattern-making.

Wrought Iron.—Properties and defects of Wrought Iron. Methods of testing, welding.

Steel.—Classification and methods of manufacture. Properties and defects of Steel. Case Hardening. Methods of testing. Heat treatment and methods of working. Carbon and Alloy Steels. Rusting and Corrosion. Methods of Preservation of Steel and Iron.

Copper.—Properties and methods of working. Useful alloys of Copper and the production of castings.

Aluminium.—Properties and methods of working. The alloys of aluminium and the production of casting.

Other Useful Metals.—The chief properties and uses of Zinc, Tin, Lead, Bismuth, Antimony, Nickel and Manganese.

Practical Demonstration—will be given in Foundry Work, Welding and Soldering and in the Testing Laboratory.

General Properties.—Elementary conceptions of Matter and Energy. Principle of Archimedes. Density and Specific Gravity. Laws of floating bodies. Hydrometers. Use of the Vernier and Micrometer Screw Gauge.

Atmospheric Pressure, Barometer, Pressure Gauge, Boyle's Law.

Heat.—Temperature and Thermometers. High temperature thermometry. Pyrometers.

Coefficients of expansion. Simple determinations of the linear coefficient of expansion. Compensation for expansion and its practical applications in Engineering.

Different units of heat; Thermal Capacity, Specific Heat and water equivalent of a calorimeter. Laws of Fusion and Vaporization. Effects of pressure on melting and boiling points. Latent Heat of fusion and vaporization.

Saturated and unsaturated vapour; relation between the maximum vapour pressure and the temperature of a liquid; Dalton's laws of vapours.

Hygrometry.—Daniel's Hygrometer. Definitions of Relative Humidity and Dew Points and the relation between the two.

Charles' law. Combination of the laws of Boyle and Charles. Absolute temperature. Isothermal and Adiabatic changes and their graphical representation. Work done in compressing a gas; Specific heats of a gas.

Transference of heat, Conduction, Convection and Radiation.

Nature of heat, Mechanical equivalent of heat and its determinations. First law of Thermodynamics, Natural sources of heat, Fuels.

Light.—Laws of Reflection and Refraction of Light. Concave and Convex Mirrors. Converging and Diverging Lenses. Determinations of focal length. Telescopes and Microscopes. Illumination and Photometry, Bunsen's Grease Spot Photometer.

Sound.—Production of Sound, Pitch, Intensity and Quality of a Note. Interference and Resonance. Velocity of Sound.

Magnetism.—Properties of Magnets. Preparations of Magnets. Unit Pole. Lines of Force. Magnetic Field and its Intensity. Flux and Flux Density. Magnetic Moment.

Laws of Magnetic Force. Intensities of the field on the axial and equatorial line of a bar magnet. Magnetometer. Oscillation of a magnet in a uniform field.

Terrestrial magnetism. The three magnetic constants at any place.

Electro-magnets.

Electricity.—Primary Cells (Daniell, Lechlanche and Dry Cells).

Practical and absolute units of current. Electromotive force. Resistance and Power.

Specific Resistance. Conductors and Insulators. Ohm's Law. Cells and resistances in series and parallel.

Magnetic effect of a current. Field at the centre of a circular coil. Tangent galvanometer. D'Arsonval Galvanometers. Moving Coil. Ammeters and Voltmeters.

Heating effect of current—Joule's Law.

Current-carrying capacity of wires—Fuse Law.

Electrolytic effect of a current—Faraday's Laws.

Electro-chemical equivalents of elements. Voltameter.

Electro-plating.

Work and Power, Definition of the Board of Trade Unit.

Use of Wheatstone's Bridge and Potentiometer.

Electrostatics.—Elementary principles. Condensers and Capacity.

The following books are recommended:—

(1) Notes on the Elements of Applied Electricity by Prof. B. C. Chatterjee.

(2) Text-book of Physics by J. Duncan and S. G. Starling.

Electrical Engineering.

Chief types of Commercial Measuring Instruments, their principles, use and care.

Magnetic Properties of Materials—Permeability. Thompson's Permeameter. Hysterisis. Electro-magnets.

Electrical Properties of Materials—Conductors and Insulators. Insulation of wires and cables. Effect of moisture and heat on conductors and insulators. Eddy currents.

Secondary cells. Elementary principles. Choice of types for various purposes. Charging and discharging of secondary batteries.

Electro-magnetic Induction. Elementary principles and essential parts of D. C. Generators and Motors.

The Field System. Series, Shunt and Compound Windings. Armature Construction.

Characteristics and efficiency. Armature Reaction and Regulation. Different types of D. C. Generators and Motors. Their selection, erection and management. Starting and regulating appliances.

Production and nature of the alternating current. Maximum and R. M. S. values of Wave Form. Effect of Resistance, Inductance and Capacity in simple circuits. Power and Power Factor. Alternators.

Electric Lighting. Carbon and metal filament lamps. Arc lamps. Currents and voltages required by the more commonly used glow lamps. Lighting and wiring of private plants. Testing lines and locating and repairing faults in lines. Switchboard in connection therewith, their construction, erection and repair.

The following books are recommended:—

(1) Elements of Applied Electricity, Vol. II., by Prof. B. C. Chatterjee.

(2) Direct Current Engineering by Barr.

Electrical Engineering Laboratory.

Electrical and magnetic measurements. Calibration of instruments. Measurement of high and low resistance. Ballistic galvanometer tests. Tests on supply meters and secondary batteries. Photometry. Line tests. Simple experiments with Direct and Alternate Current Dynamos and Motors.

Licentiate Diploma Examination

in

Mechanical and Electrical Engineering.

The grouping in the Final Diploma Mechanical and Electrical Engineering Course shall be as follows:—

Group.	Subject.	Nature of Examination.	Full Marks.	Pass Marks.
I.	Advanced Workshop Practice and Laboratories ...	Sessional work	250	150
II.	Electrical Design, and Mechanical Design	Sessional work	250	150
III.	Applied Mechanics ...	Written 3 hours	100	80
	Prime Movers ...	,, ,,	100	
IV.	Electrical Engineering (Continuous Current) ...	,, ,,	100	80
	Electrical Engineering (Alternate Current)	,, ,,	100	
V.	Workshop Management ...	,, ,,	100	40

Minimum pass marks for Groups I and II ... 60 per cent.

,, ,, ,, ,, ,, III, IV and V 40 ,, ,,

,, ,, ,, on Aggregate ... 60 ,, ,,

,, ,, ,, for First Class ... 70 ,, ,,

Applied Mechanics.

In addition to a more thorough familiarity with the preliminary syllabus:—

The elastic constants for steel, iron and non-ferrous alloys, and the strength of stone, brick and the more familiar Indian timbers, Resilience and overstrain.

Beams, their strength and resilience including encastré beams and simple continuous beams. Composite sections and trussed beams.

Torsion of round shafts both solid and hollow.

Springs, Helical, Spiral, and Carriage Springs.

The commercial testing of steel, iron and building materials. The assumptions of Clerk-Maxwell stress diagram. Deficient and redundant frames in two and three dimensions. Applications of the funicular polygon to determine bending moments, moments of inertia, deflection, the shapes of, and stresses in, suspension structures, struts, and columns. Formula of Euler and Rankine. Braced and built up columns. Grillages.

Plate girders. Flange areas. Rivet pitches. Deflections. Webs and stiffeners.

Flow of water in pipes and channels. Critical velocity. Power transmission. Water hammer. Pumps and pumping. Centrifugal, reciprocating and other types of pumps including air lifts. The measurements of flowing water.

The steam engine mechanisms. Toothed wheels, including spiral gears and epicyclic trains. Belt and rope driving. Bearings. Current literature.

Prime Movers.

In addition to a more thorough familiarity with the preliminary syllabus:—

Relations between power, speed and dimensions of reciprocating steam engines. The usual valve gears and calculations connected therewith. Fuel and steam consumptions. Construction and capacity of boilers. Condensers. Other steam plant auxiliaries.

Internal combustion engines. Relations between power, speed and dimensions. Valve timing. Ignition and carburation. Fuel and lubricating oil consumptions. Air compressors.

Refrigerating Plant. Gas Producers. Steam Turbines, De Laval, Parsons, Curtis, Rateau, and Zoelly types. The turbine condenser and air pump. Governing of steam turbines. Labyrinth and other packing. Other structural details.

Water turbines and wheels. Windmills. Current literature.

Continuous Current Electrical Engineering.

Measuring instruments and testing. Laws of the magnetic circuit and calculations thereon.

C. C. generators and motors; principles of and essential parts; elements of design and simple calculations connected therewith; calculations of and tests for losses, efficiencies, and characteristics.

Secondary batteries, principles of; usual forms; testing. Setting up and maintenance.

Electric lamps and lighting; glow arc, mercury vapour, and other lamps; principles involved, use and testing.

Generation and Control of Power.

Power transmission and distribution by continuous currents. Electric traction by continuous currents.

Alternate Current Electrical Engineering.

Theory of alternate currents; elementary mathematical theory; units and measurement.

A.C. generators and motors; Theory and maintenance and testing; Elements of design and simple calculations connected therewith.

Transformers and converters. Theory, use, maintenance and testing. Simple calculations concerning testing.

Generation and Control of Power.

Power transmission and distribution by alternate currents. Electric traction by alternate currents.

Books recommended for Electrical Engineering:—

(1) Elements of Applied Electricity, Vol. III, by Prof. B. C. Chatterjee.

(2) Electrical Engineering Practice by J. W. Meares.

(3) Dynamo and Motor Control by Ibbetson.

Electrical Engineering Laboratory.

Standardisation of Measuring Instruments. Measurement of Self-induction, Capacity, Power and Power Factor. Complete Tests on Direct Current Dynamos and Motors. Storage Battery Work.

Tests on Transformers, Induction Motors, Rotary Converters and Synchronous Motors. Traction Motor Tests. Parallel Operation of Continuous Current Dynamos and Alternators. Line Tests.

High Voltage Testing.

Workshop Management.

Money, and market price. Capital. Foreign Currencies and Exchange. Transaction abroad. Book-keeping. Office Routine. Correspondence and Filing Systems. Choice of Site. Layout of Buildings. Choice of a Prime Mover. Time-keeping. Gate Control. Depreciation. Valuation. Costing Systems. Store-keeping. Overhead Charges. Current Prices of Labour and Material. Jigs and Fixtures. Speeds and Feeds. Time, Piece-work, Bonus, and Task Systems of Wage Payment. Profit Sharing. Trade Unions. Workmen's Share in Management. Accurate Measurement. Principles of Mass production. Limit and other Gauges. The Tool Room. Factory Legislation. Patents and Trade Marks.

Book recommended:—

Economics of Engineering by Profs. B. C. Chattérjee and L. D. Coueslant.

PORTION OF FOUNDRY.

Licentiate Diploma Examination in Civil Engineering.

The grouping in the Final Diploma Civil Engineering Course shall be as follows:—

Group.	Subject.	Nature of Examination.	Full Marks.	Pass Marks.
I.	Surveying ...	Sessional work	250	150
II.	Structural Drawing and Design ...	,, ,,	250	150
III.	Hydraulics and Water-works ...	Written 3 hours	100	80
	Irrigation and Sanitation ...	,, ,,	100	
IV.	Roads and Railways ...	,, ,,	100	80
	Structures ...	,, ,,	100	
V.	Office Routine and Estimates ...	,, ,,	100	40

Minimum pass marks for Groups I and II ... 60 per cent.

,, ,, ,, ,, ,, III, IV and V 40 ,, ,,

,, ,, ,, on Aggregate ... 60 ,, ,,

,, ,, ,, for First Class ... 70 ,, ,,

Hydraulics.

Hydrostatics. Total pressure. Resultant pressure. Equilibrium of floating bodies. Stability of Dams. Bernoulli's Law. Orifices. Weirs. Pipe-line problems. Pumps and pumping. Turbines. The Pelton, Francis and Propeller Turbine. Specific speeds. Water hammer and surge tanks. Governing. Wells and well sinking. Perennial tanks. Other sources of water supply. Catchment areas. Rainfall and Run-off. Drainage of Storm Water. Storage of Water. Channels. Purification, Distribution and Measurement.

Irrigation and Sanitation.

Benefits and disadvantages of irrigation. Canalization of Rivers. Gravity and power distribution. Economics of an irrigation system. Water Supply, relation of water supply to area supplied, population and the local climate. Detail distribution. Suitable and unsuitable soils. Evaporation. Sewage and sewers. Use of and disposal of sewage. Sanitary pulmbing, construction of Latrines and Urinals. Municipal Laws. A general idea of sewage-borne diseases, and method of prevention within the Engineer's power.

Structures.

Materials, their physical properties and costs. Strains and stresses. Elastic constants. Beams, strength and stiffness. Plate girders. Columns. Deficient, sufficient and redundant frames. Suspension structures. Frame bridges. Dead and live loads. Steel and iron tanks. Stability of masonry structure. Dams and retaining walls. Reinforced concrete and brick work. Structural steel work in buildings. Buildings and building laws. Elements of Architecture.

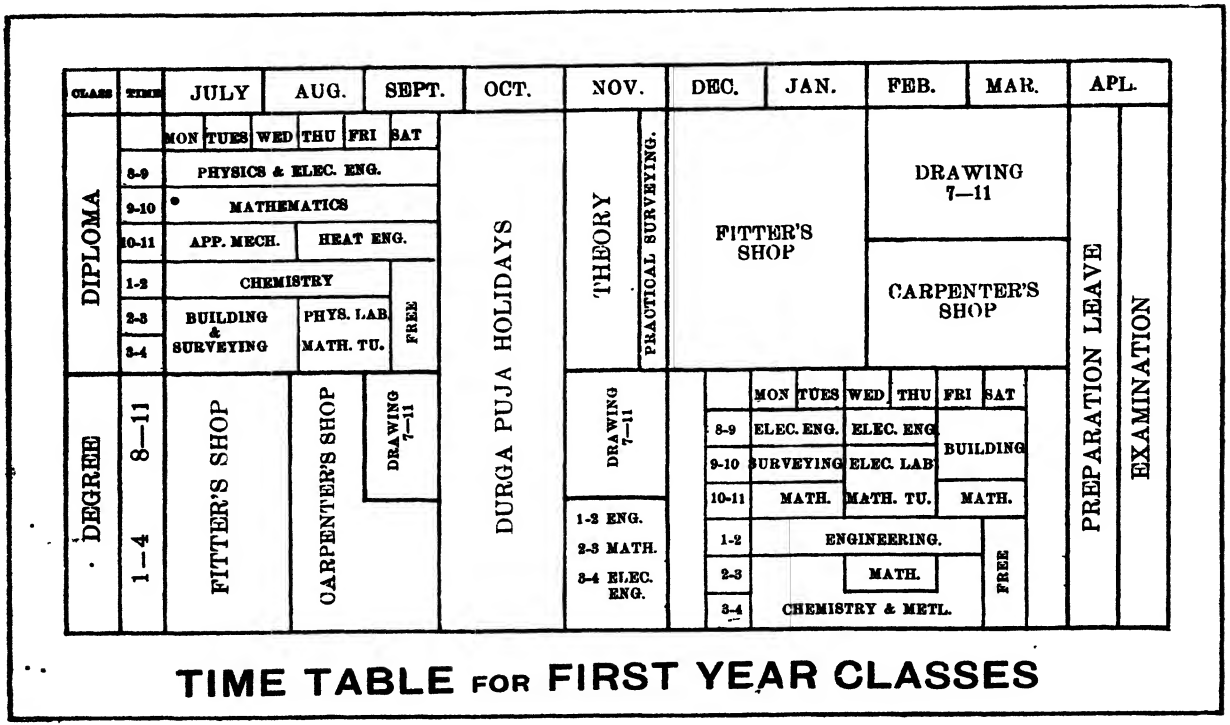
Roads and Railways.

Economic relations between Roads and Railways. Kutcha and Permanent Roads. Materials for Road-making. Construction and drainage. Culverts for storm and ordinary water. Cost and maintenance. City Roadways and Streets. Town Planning.

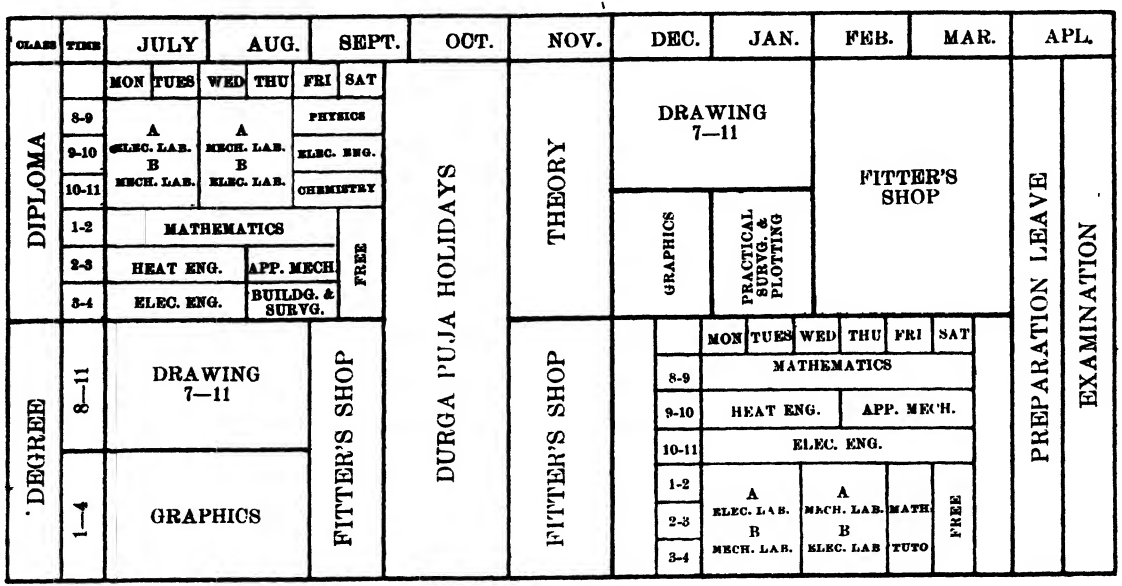
Classification of Railways, Gauges, Electric Railways, Light Railways, Temporary Railways for contract work, Reconnaissance, Preliminary Survey, Gradients, Embankments and Cuttings. Office Location. Field Location. Permanent Way. Stations and subsidiary buildings. Rolling Stock. Traffic Management. Maintenance. Freights, Tariffs.

Office Routine and Estimates.

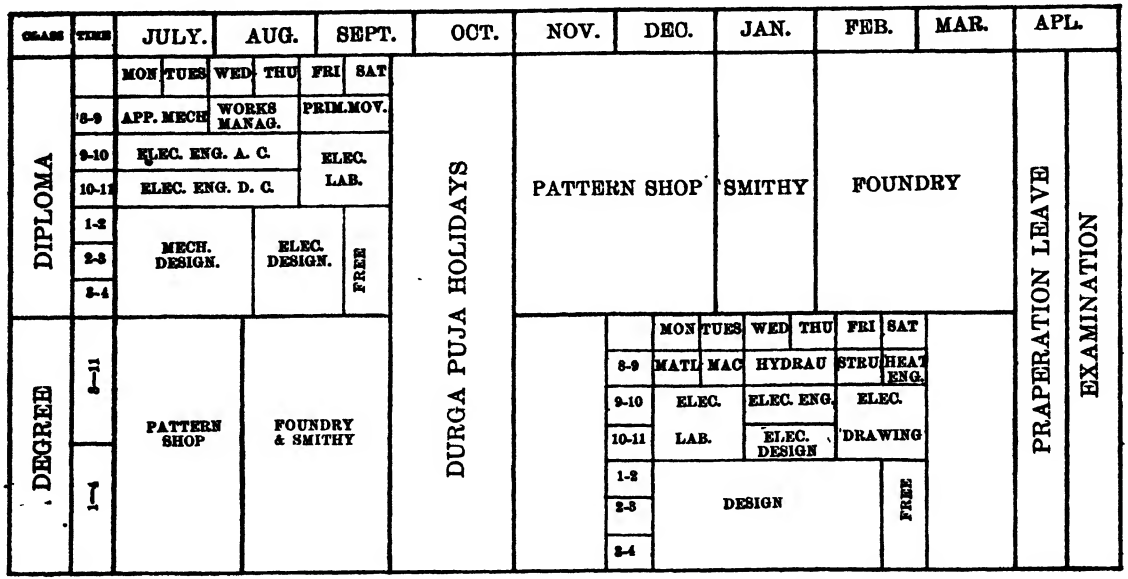
Money and Market Price. Capital. Foreign Currencies and Exchange. Transactions abroad. Book-keeping, Correspondence, Filing Systems. Depreciation. Valuation. Store-keeping. Current Prices of Labour and Material. Cost of Transport. Systems of Wage Payment. Law of Contract. Other Industrial Laws. Quantities and Estimates.



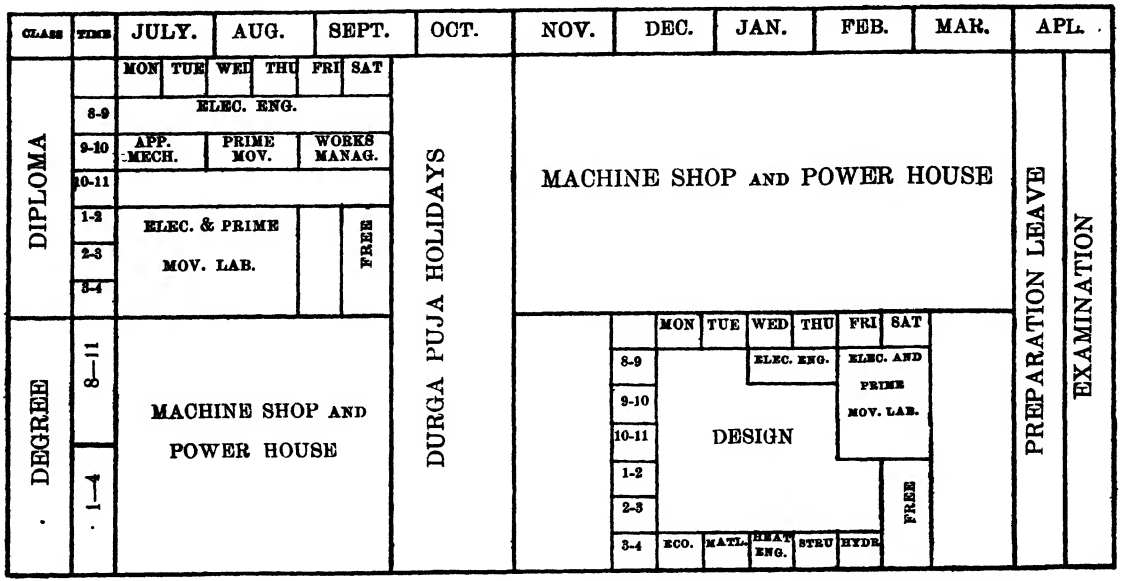
TIME TABLE FOR FIRST YEAR CLASSES



TIME TABLE FOR SECOND YEAR CLASSES



TIME TABLE FOR THIRD YEAR CLASSES



TIME TABLE FOR FOURTH YEAR CLASSES

EXAMINATION PAPERS
SESSION 1925-26

Intermediate Science (Engineering), Part I, 1926.

Subject:—MATHEMATICS.

PAPER I.

Paper-setter and Examiner—Sohan Lal, M.Sc.

Time—Three Hours. Full Marks—100.

ANSWER SIX QUESTIONS ONLY.

THE QUESTIONS ARE OF EQUAL VALUE.

1. Draw the graphs of Sin x and e^{-x}, between $x=0$ and $x=3'142$. Solve the equation e^{x} Sin $x=1$.

2. (*a*) A straight line moves so that the sum of the reciprocals of its intercepts on two fixed intersecting lines is constant; shew that it passes through a fixed point.

   (*b*) The equation y^2-2xy Sec $\theta+x^2=0$ represents two straight lines passing through the origin and making an angle θ with one another. Prove this.

3. P C P′ and D C D′ are a pair of conjugate diameters of an ellipse. ϕ and ϕ^1 are the eccentric angles of P and D respectively. Prove that:—

   (*i*) $\phi \sim \phi^1 = \frac{\pi}{2}$

   (*ii*) C P^2 + C $D^2 = a^2 + b^2$.

   (*iii*) Area of the parallelogram which touches the ellipse at P, P′, D and D′ is equal to $4ab$.

4. (*a*) Differentiate

(*i*) $\frac{1+x^2}{\sqrt{1-x^2}}$ (*ii*) $7'2 \tan \frac{x}{8} \log x^7$

(*iii*) $\cos^{-1}x + \cos^{-1}\sqrt{1-x^2}$ (*iv*) $\frac{(1+x)^n}{(1-x)^n}$

(*b*) If $y = A e^{nx} + B e^{-nx}$, where A and B are constant, show that $\frac{d^2y}{dx^2} - n^2y = 0$

5. Explain clearly what you understand by the Radius of Curvature and show that it is equal to $\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{\frac{3}{2}} \Big/ \frac{d^2y}{dx^2}$. Find the radius of curvature of the ellipse, $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, at the point (o, b).

6. A vessel in the form of a right circular cone, whose height is 7 ft. and diameter of its base 6 ft., placed with its axis vertical and vertex downwards, is being filled with water at the rate of 10 cu. ft. per min.; find the velocity with which the surface is rising (*a*) when the depth of water is 4 ft. and (*b*) when 60 cu. ft. have been poured in.

7. Explain the method of finding the maximum and minimum values of a function with a single independent variable.

The weight of gas which will flow per second through an orifice from a vessel where it is at pressure ρ_0 into another vessel where it is at pressure ρ is proportional to $\frac{1}{a\gamma}\sqrt{1 - \frac{\gamma-1}{a\gamma}}$ where a is ρ/ρ_0 and γ is a known constant. When is this a maximum?

8. (*a*) If $\frac{1}{1-E}=(r)^{\frac{R}{K}}$, prove that $\frac{dE}{dK}=-\frac{R}{K^2}\left(\frac{1}{r}\right)^{\frac{R}{K}}\log r$.

(*b*) The length of arc measured from a fixed point on a certain curve is $S=x^2+x$. Find the slope of the curve at $x=2$.

9. Integrate

$$\int \frac{x\,dx}{\sqrt{x^4-1}} \qquad \int \frac{dx}{\sqrt{3-2x^2}}$$

$$\int \frac{dx}{e^x+e^{-x}} \qquad \int \frac{dx}{1-\sin x}$$

$$\int \frac{x^2+1}{x(x^2-1)}\,dx \qquad \int x\tan^{-1}x\,dx$$

10. The segment of the parabola $y^2 = 2ax$, cut off by the line $x = a$, is revolved about the x axis. Find the surface, volume and the centre of gravity of the solid generated.

11. A cone, diameter of base $1\frac{1}{2}''$, length of axis $2''$, rests with its base on the ground, and is cut by a plane bisecting the axis inclined at 45° to the H. P. and perpendicular to the V. P.

Draw the plan and elevation of the cone, showing the trace of the section plane on its surface.

Draw the true shape of the section of the cone where it is cut by the inclined plane.

Intermediate Science (Engineering), Part I, 1928.

Subject:—MATHEMATICS.

PAPER II.

Paper-setter and Examiner—S. N. Maitra, I.E.S., M.A., A.R.C.Sc.

Time—Three Hours. Full Marks—100.

ANSWER SEVEN QUESTIONS ONLY.

ALL QUESTIONS CARRY EQUAL MARKS.

1. Show that the resultant of a force and a couple in the same plane is a single force.

   Ox, Oy are rectangular axes, and P is a point whose co-ordinates are (3, 4). Find the intercepts made on Ox, Oy by the line of action of the resultant of a force of 7 units along OP and a counterclockwise couple of moment 21 units.

2. A body of mass M has a movable part of mass m; prove that, when the movable part is displaced so that its centre of gravity moves through a distance c, the centre of gravity of the whole is displaced through a distance $\frac{mc}{M}$ in the same direction.

   A sheet of paper is in the shape of a rectangle, 9 inches wide by 12 inches long; one of the shorter sides is folded down, so as to be entirely along one of the longer sides; find the position of the centre of gravity of the whole sheet when thus folded.

3. A weight rests on a rough inclined plane, whose inclination α exceeds the angle of friction λ, being prevented from sliding by a force P. Find (geometrically or otherwise) the direction and magnitude of the least force which will suffice for this purpose.

A uniform ladder rests with its foot on the rough ground, and its upper end against a smooth wall, its inclination to the vertical being θ. Prove that a horizontal force applied to the foot to make it approach the wall must exceed $W(\mu + \frac{1}{2}\tan\theta)$, where W is the weight of the ladder, and μ the coefficient at the foot.

4. State necessary and sufficient conditions for the equilibrium of a system of co-planar forces.

A rod of length a and weight W is supported in a horizontal position by two strings of length a attached to the ends of the rod and to two rings of weight $\frac{W}{4}$ which are free to move along another fixed rough horizontal rod. Shew that the greatest distance apart of the rings consistent with equilibrium is $a\left\{1 + \frac{6\mu}{\sqrt{9\mu^2 + 4}}\right\}$

5. Define momentum. If the momentum of a system varies, explain how the force acting on it is to be measured.

A jet of water of cross-section 3 square inches and velocity 40 feet per second impinges normally on a plane inelastic wall, so that the velocity of water is destroyed on reaching the wall. Calculate in lbs. weight the thrust on the wall.

6. An engine of mass 105 tons is coupled to and pulls a carriage of mass 30 tons; the resistance to the motion of the engine, $\frac{1}{100}$ of its weight. Find the tension in the coupling if the whole tractive force exerted by the engine is equal to the weight of 6,000 lbs.

7. Show that if a point P move in a straight line towards a fixed point O in the line under an acceleration equal to μ OP, μ being a constant, then $OP = a \sin(\sqrt{\mu}t + b)$, where a and b are constants.

Prove that two simple harmonic motions of amplitudes a and b, with a difference of phase ϵ, and common frequency, $\frac{\lambda}{\pi}$, compound into a simple harmonic motion; find its amplitude.

8. Explain a method of determining the specific gravity of a solid which is (*a*) heavier, (*b*) lighter than water.

A piece of wood weighs 144 grammes in air and a piece of metal weighs 36 grammes in water. When fastened together the two weigh 24 grammes in water and 8 grammes in a solution of specific gravity 1·1. Find the specific gravities of the wood and metal.

9. State and prove the rule for finding the thrust on a plane area which is subject to the pressure of a heavy homogeneous liquid.

The depth of water in a rectangular cistern is 4 ft. If half an inch of the water evaporates, what rise in the height of the barometer will make the magnitude of the pressure on a side of the cistern equal to its former value? (The specific gravity of mercury is to be taken as 13·5, and the original height of barometer as 30 in.)

Intermediate Science (Engineering), Part I, 1926.

Subject:—ENGINEERING.

Paper-setter and Examiner—O. A. King, B.Sc., A.R.C.Sc., M.I.M.E., M.I.S.E., M.I.E.

Time—Three Hours. Full Marks—100.

ANSWER SIX QUESTIONS ONLY.

ALL QUESTIONS ARE OF EQUAL VALUE.

No marks will be given for incorrect or slovenly work.
Extra marks will be given for neatness.

1. A motor car weighing 4,200 lbs. ascends an incline of 1 in 20 at a steady speed of 15 miles an hour, when developing 12 horse-power. Determine the wind resistance if the road and frictional resistances combined amount to 50 lbs.

   Assuming the wind resistance to be proportional to the square of the speed, and that the other resistances remain constant, estimate the maximum speed on the level when developing the same power.

2. Define Centre of Pressure.

   A rectangle, 2 feet by 6 feet, is immersed in water with its plane at 30° to the vertical, and the upper 2 feet side horizontal and at 4 feet below the surface. Find the resultant pressure on one side of the rectangle and the position of the centre of pressure.

3. A train consists of 10 trucks, each of which weighs 12 tons. The diameters of the journals are 4 inches, and the diameters of the wheels 3 feet.

   The coefficient of friction between the journals and their bearings is 0.06. Find the resistance of the train due to axle friction, and the horse power required to draw the train on the level at 20 miles per hour against this axle friction alone. In practice, what other important resistances have to be considered?

4. Sketch and describe briefly some form of vertical steam boiler and enumerate the fittings and equipment that should be supplied with the boiler.

5. A jet of water, 2 inches in diameter, issues from a nozzle at 50 feet per second, and impinges normally on a flat plate moving at 20 feet per second in the direction of the jet. Find the pressure on the plate, the work done on the plate per second, the work per second necessary to maintain the jet, and the efficiency of the arrangement.

6. A beam, 40 feet long, is carried on three supports, one at each end and one at the centre of the length. The beam carries a uniform load of 2 tons per foot over its whole length, and the supporting force at the centre is 46 tons.

   Draw the bending-moment and shearing-force diagrams, stating the greatest positive and negative values of shear and moment and where they occur.

7. A centrifugal pump is directly coupled to an electric motor. The pump is required to deliver 1,800 gallons of water per minute to a height of 220 feet, the revolutions of the wheel and shaft being 1,500 per minute.

   If the efficiency of the pump is 70 per cent., find the necessary diameter of the shaft that the shear stress may not exceed 5 tons per square inch. One gallon of water weighs 10 lbs.

8. The travel of a simple slide valve is 3 inches and the connecting rod is equal in length to four cranks. Take the lead on the forward stroke as $\frac{1}{4}$ inch and the cut off for both the forward and the backward strokes at $\frac{5}{8}$ths of the stroke. Find the outside laps, and the lead on the return stroke, also the angle of advance of the eccentric.

9. Sketch and describe a simple steam engine naming all the parts and the materials of which they are made.

Intermediate Science (Engineering), Part I, 1926.

Subject:—MECHANICAL DRAWING.

Examiners—Principals F. Walford, Wh.Sc., M.I.M.E.; C. A. King, B.Sc., A.R.C.Sc.

Time—Four Hours. Full Marks—100.

QUESTION ONE MUST BE ATTEMPTED.

1. The drawing on next page represents two views of a connecting rod end with Strap, Gib, and Cotter.

   Draw the two views shown and add an *end elevation* looking in the direction of the arrow. *Scale* $\frac{3}{4}$ *Full Size.*

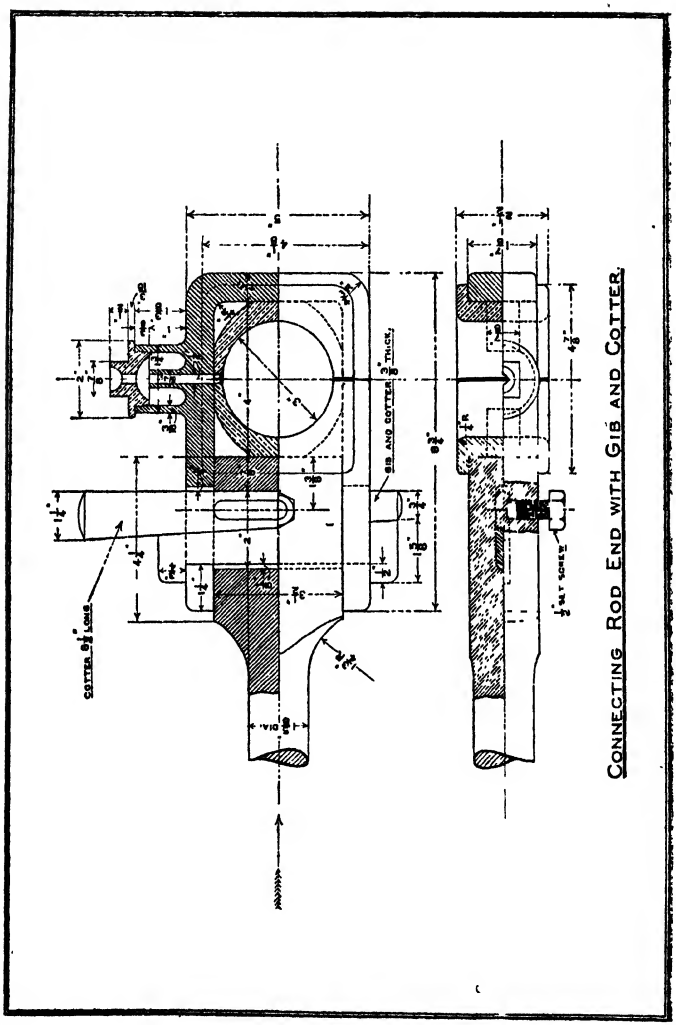
   Note on your drawing the materials of which the several parts are made.

2. How are the brasses of the connecting rod end of question 1 adjusted for wear?

3. Show, by sketches, four totally different methods of locking nuts.

4. Show by sketches the forms of the Whitworth, Seller's and French Vee threads and also square and buttress threads (mark the proportions of these threads taking the pitch one inch).

5. Show by sketches three methods of preventing a bolt from rotating while the nut is being screwed on or off.



CONNECTING ROD END WITH GIB AND COTTER.

Intermediate Science (Engineering), Part I, 1926.

Subject:—BUILDING AND BUILDING MATERIALS.

Paper-setter and Examiner—H. K. Sen, M.I.M.E.

Time—Three Hours. Full Marks—100.

[ANSWER QUESTIONS 5, 6, 7, 8, AND ANY TWO FROM THE FIRST FOUR.]

1. What are the chief points to look to in choosing a building stone? Into what classes are stones divided as regards their methods of formation? How can one class usually be distinguished from the other? Mention two examples of each class and the uses to which they are put.

2. What is mortar? What are its uses? What precautions are necessary in using it? What are the qualities to be sought for in good mortar?

3. Distinguish between Sal, Mahogany, Bamboo and Teak as timber and compare them in regard to durability and cost. What precautions are necessary in using timber in buildings?

4. A sample of Portland cement to be used in concrete has to be tested for tensile strength. Describe the tests usually made, and state what results may be expected from a good brand of cement.

5. Give a neat dimensioned sketch of a wooden King Post Truss. Give details of all joints.

6. What are the main points to consider in designing foundations of machinery? Illustrate your answer by examples.

7. Explain by sketches the following:—

   (*a*) Relieving arch. (*b*) Skewback. (*c*) Benching out. (*d*) Squared rubble (uncoursed) with ashlar quoins. (*e*) Brick-on-edge flooring, herringbone pattern.

8. A circular chimney is required for a range of five Lancashire boilers.

   (*a*) Draw to scale a sectional plan of the chimney at a height of 30 feet above G L., giving dimensions.

   (*b*) State the number of ordinary bricks you would require for its construction including wastage.

Intermediate Science (Engineering), Part I, 1926.

Subject:—SURVEYING.

Paper-setter and Examiner—C. J. Veale, F.R.A.S., F.R.G.S.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

1. A three-foot-screw Dumpy Level, on a stand, is to be put into correct adjustment. Describe shortly, step by step, and in order, the correct method of doing it and what precautions apply to the stand.

2. Describe the adjustment for vertical collimation *only* of a transit theodolite. A Level staff is not to be used.

3. The following is a closed traverse:—

Side.	Length.	Azimuth from N.
AB	391 feet	42°—38′
BC	...	...
CD	407 feet	250°—18′
DE	791 „	280°—53′
EA	782 „	61°—5′

Find length and azimuth of BC.

4. Tabulate a 3° curve of length 350 feet from T.P. to T.P. giving angles to be read on a theodolite for pegs 100 feet apart, at the two T.P.s and also on the third peg, as it is assumed that not more than 300 feet is visible.

5. You are given a Level and no means of adjusting it, also its stand and a Level Staff. Give all the precautions you would take to obtain good results. A chain is used for measuring distances.

6. Complete the following page from a Level book:—

Distance	Station.	B.S.	I.S.	F.S.	H.I.	R.L.
Feet	BM 1	8·72	..	. .	...	105·49
0	1	...	2·13	...	...	...
100	2	...	1·05	...	...	...
200	3	7·45	...	0·21	...	...
300	4	...	4·17	.	...	. .
400	5	10·89	...	2·63	. .	...
500	6	. .	. .	5·74	.	...

7. What do you consider are the limits of closing error in the following?

   (*a*) A chained distance of 1,000 feet.

   (*b*) In inward angles at 5 traverse stations using a theodolite divided to read one minute.

   (*c*) A 14-inch Dumpy Level on a moderately flat piece of ground; distance one mile of levelling.

Intermediate Science (Engineering), Part I, 1926.

Subject:—ENGINEERING PHYSICS.

Paper-setter and Examiner—G. C. Mukerji, M.Sc.

Time—Three Hours. Full Marks—100.

[ANSWER QUESTIONS 1, 2 AND ANY FOUR ADDITIONAL QUESTIONS.]

1. An oil engine gave 6.2 brake-horse-power for an oil consumption of 5.64 lbs. per hour. If the heating value of the oil is 10,500 lb.-deg.-cent. units, what percentage of the heat supplied in the oil is converted into useful work?

2. Define the efficiency of a heat engine and show why it is that only a small proportion of the heat absorbed by a heat engine reappears in the form of useful work. If an engine and boiler consume 3 lbs. of coal per hour per horse-power and the heat developed during the combustion of each pound of coal is sufficient to convert 12½ lbs. of water at 62°F. into dry saturated steam at an absolute pressure of 100 lbs. per square inch (temperature, 327.9°F.), what, under these circumstances, is the efficiency of the engine, the boiler efficiency being taken as 72 per cent?

3. Define unit pole, unit potential, unit field, and establish expressions for the potential and field at any point due to a very small bar magnet.

4. Two equal bar magnets are fastened rigidly together at right-angles. Show that the greatest couple exerted on them by the earth's horizontal force will be $\sqrt{2}$ times the greatest couple exerted on each separately.

5. An iron ring 3 sq. c.m. in cross-section and 50 c.m. in mean circumference is wound with a coil of 100

turns. It is found that a current of 8 amperes produces a flux of 40,000 lines. Find the permeability of the iron.

6. A storage battery of 55 accumulators, having an E.M.F. of 1.8 volts and an internal resistance of .0125 Ohm per cell is connected to mains maintained at a constant pressure of 143 volts. Determine (*a*) the charging current at starting and (*b*) the resistance which must be introduced if the charging current is not to exceed 40 amperes.

7. A dynamo produces a constant potential of 120 volts at its terminals and is 300 yards away from a house where there are two hundred 100 volt 35 watt glow lamps in parallel. What size leads should be employed between the dynamo and the house if the resistance of an inch cube of copper is .66 microhm? Find also (i) the electrical horse-power supplied at the house, (ii) the Board of Trade units supplied in 10 hours, and (iii) the cost of the energy at 4d. per unit.

8. A short piece of lead wire having an emissive power of .00025 is used as a fusible cut-out. Determine its diameter so that a current of 7.2 amperes may just fuse it.

   Specific Resistance of lead = 19.85 microhms.

   Melting point of lead = 335° C.

   Room temperature = 10° C.

9. Show how to calibrate a moving coil ammeter by a potentiometer, discussing fully all the precautions which have to be taken for high accuracy.

   Or

   Give neat diagrammatic sketches explaining the principles of action of

   (1) Evershed's Megger.

   (2) Any type of house-meter.

Intermediate Science (Engineering), Part I, 1926.

Subject:—ENGINEERING CHEMISTRY.

Paper-setters and Examiners—C. A. King, B.Sc., A.R.C.Sc., M.I.M.E., M.I.S.E. M.I.E.; Dr. N. R. Dhar, D.Sc.

Time—Three Hours. Full Marks—100.

NOTE:—(*a*) USE A SEPARATE ANSWER BOOK FOR EACH SECTION.

(*b*) ANSWER THREE QUESTIONS ONLY IN EACH SECTION.

(*c*) MARK THE NUMBER OF SECTION CLEARLY ON THE FRONT COVER OF EACH ANSWER BOOK.

SECTION I.

1. What is Portland Cement, and how does it behave when mixed with water to form a mortar? State the action, if any, of aqueous solutions of acid and of alkali on Portland Cement, and give the compositions of cements capable of resisting the action of hydrochloric and sulphuric acids.

2. Describe one *industrial method* of separating (*a*) two insoluble solids, and (*b*) a solid insoluble in water, from one soluble; giving sketches of the necessary plant, and referring to any conditions necessary to secure effective and economical working.

3. What do you understand by such expressions as First Class, Good Second Class, Second Class, and Third Class Indian Coals? Name some of the seams or localities from which you can obtain the above mentioned coals with their current prices per ton at the collieries.

Why is a coal washed? Do Indian coals lend themselves to washing? Give reasons for your answer.

4. How do the impurities present in coal, such as sulphur, phosphorus, etc., affect our judgment as to its commercial value?

   How do you determine the coking value of a coal?

5. Name the principal liquid fuels, and write a short account of the occurrence and properties of any one of them, giving approximately the specific gravity, range of distillation, calorific value, and elementary composition.

Section II.

1. Discuss the following statement of Sir George Beilby, a great leader in Engineering Chemistry:—

   "An early training in the doctrines of atomic and molecular theories is of the greatest service to an Engineer."

   Can you justify the above statement?

2. Write an essay on Combustion.

3. Building stones, such as granite, limestone, sandstone, slate, brick, etc., are generally subjected to certain physical tests in addition to a chemical analysis.

   What chemical and physical tests would you apply to determine accurately the relative value of a building stone?

4. Write an essay on the Chemistry of corrosion of metals by air and water.

5. Write a note on the vulcanisation of rubber. What are rubber substitutes?

Intermediate Science (Engineering), Part I, 1926.

Subject:—ENGINEERING METALLURGY.

Paper-setters and Examiners—C. A. King, B.Sc., A.R.C.Sc., M.I.M.E., M.I.S.E., M.I.E.; Dr. N. R. Dhar, D.Sc.

Time—Three Hours. Full Marks—100.

NOTE:—(*a*) USE A SEPARATE ANSWER BOOK FOR EACH SECTION.

(*b*) ANSWER THREE QUESTIONS ONLY IN EACH SECTION.

(*c*) MARK THE NUMBER OF SECTION CLEARLY ON THE FRONT COVER OF EACH ANSWER BOOK.

SECTION I.

1. Sketch the iron-carbon-equilibrium diagram. Show how a knowledge of such a diagram is essential for the determination of the heat treatment necessary to enable steels to be used commercially for different purposes.

2. What do you understand by hot and cold working of metals? Describe the effect of hot and cold working on steel.

   State what you know of the influence of casting temperature on the properties of cast-iron.

3. What are the essential properties of an anti-friction alloy? Describe briefly the classes of alloys used for this purpose—giving also the approximate composition.

Describe with sketches, how a bearing is lined with anti-friction or " White metal."

4. State the general effects of adding nickel, tungsten, manganese, and vanadium to steel. What is the result of adding more than one of these elements to the same steel.

5. Describe the usual methods of classification of binary alloys. Draw typical equilibrium diagrams for the principal classes.

Section II.

1. How is steel manufactured by the Tata Iron and Steel Company at Jamshedpur? Describe the various stages of the process before the final product is put on the market.

2. What are the important ores of iron? What are the methods for the commercial sampling of iron ores?

3. How is nickel manufactured? What are the uses of this metal?

4. How can you prepare a sample of metallic manganese? What are the uses of this metal?

5. Write a note on Sands and their relative values from the point of view of a metallurgist.

What are the essential characteristics of a good Foundry Sand?

Intermediate Science (Engineering), Part II, 1926.

Subject:—MATHEMATICS.

PAPER I.

Paper-setter and Examiner—S. N. Maitra, I.E.S., M.A., A.R.C.Sc.

Time—Three Hours. Full Marks—100.

ANSWER SEVEN QUESTIONS ONLY.
ALL QUESTIONS CARRY EQUAL MARKS.

1. (*a*) Find $f'(x)$ in the following cases :—

$(i)\ f(x)=\log\sqrt{\frac{\sqrt{1+x^2}+x}{\sqrt{1+x^2}-x}}$, $(ii)\ f(x)=\tan^{-1}\sqrt{\frac{1-\cos x}{1+\cos x}}$.

(*b*) A piston is s feet from one end of a cylinder of diameter d inches, and steam is admitted at the rate of v cubic feet per second. At what rate is the piston moving ?

2. There is a piece of mechanism whose weight is 200 lbs. The following values of s in feet show the distance of its centre of gravity (as measured on a skeleton drawing) from some point in its straight path at the time t seconds from some era of reckoning. Find its acceleration at the time $t = 2{\cdot}05$, and the force in lbs. which is giving this acceleration to it.

s	0·3090	0·4931	0·6799	0·8701	1·0643	1·2631
t	2	2·02	2·04	2·06	2·08	2·10

3. The pressure p of the atmosphere at an altitude h kilometres is given by $p=p_0e^{-kh}$; p_0 beingthe pressure at sea-level (760 mm.). The pressures at 10, 20 and 50 kilometres being 119·2, 42·2, 0·32 millimetres respectively, find k in each case. Using the mean value of k, find the percentage error in each case.

4. In the catenary $y=a\text{Cos}\frac{x}{a}$, prove that (a) the length of the portion of the normal intercepted between the curve and the axis of x varies as y^2; (b) the radius of curvature, $\rho=\frac{y^2}{a}$.

5. (a) Examine the function, $4\text{ Cos }x+\text{Cos }2x$, for maxima and minima.

   (b) The strength of a rectangular beam of given length is proportional to the breadth of the section multiplied by the square of the depth. Find the strongest beam which can be cut from a cylindrical log 12 inches in diameter.

6. Integrate: —

$$(i)\int x^2\sin x\,dx,\quad (ii)\int\sqrt{1-x^2}\,dx,\quad (iii)\int\left(\frac{a+x}{x}\right)^{\frac{1}{2}}dx$$

7. A prism initially of length l under a load P_1 is compressed to a length $l-\lambda$ when the load is P. Assuming $P_1l=P(l-\lambda)$, shew that the work done during the compression λ is $P_1l\log_e\frac{l}{l-\lambda}$.

8. Show that the co-ordinates of the centre of gravity of any solid are given by

$$\bar{x}=\frac{\iiint\rho x\,dx\,dy\,dz}{M},\quad \bar{y}=\frac{\iiint\rho y\,dx\,dy\,dz}{M},\quad \bar{z}=\frac{\iiint\rho z\,dx\,dy\,dz}{M}$$

   where M is the mass of the solid and ρ the density at any point.

   Where is the centre of gravity of a uniform solid in the shape of an octant of an ellipsoid?

9. (*a*) Solve the equations :—

(*i*) $xy + (l^2 - x^2)\frac{dy}{dx} = 0$; (*ii*) $ydx + 2xdy = 0$

(*b*) The rate of cooling of a body is given by $\frac{d\theta}{dt} = -0{\cdot}01\theta$, where θ° is the excess of its temperature above that of the surroundings, which is 15°C. Find the temperature of the body 3 minutes after its temperature is 45°C.

Intermediate Science (Engineering), Part II, 1926.

Subject :—MATHEMATICS.

PAPER II.

Paper-setter and Examiner—Sohan Lal, M.Sc.

Time—Three Hours. Full Marks—100.

ANSWER SIX QUESTIONS ONLY.

THE QUESTIONS ARE OF EQUAL VALUE.

1. A body weighing 3,000 lbs. was lifted vertically by a rope, there being a damped spring balance to indicate the pulling force F lbs. of the rope. When the body has been lifted x feet from its position of rest the pulling force was automatically registered as follows :—

X	0	20	40	65	75	95	110	140
F	8000	7950	7800	7500	7400	6800	6400	4000

Find the work done on the body when it has risen 80 feet. How much of this is potential energy and how much is kinetic energy?

Find also the work done when it has risen 140 feet.

2. Calculate the greatest and least M. of I. of a T-iron section 5 inches wide, 4 inches deep, and ½ inch thick. Construct the Momental Ellipse for this section.

3. Find the shape assumed by flexible cable of uniform cross-section loaded with its own weight only; the weight per foot being " W." Find also expressions for the length of arc and the tension at any point.

A cable weighing 4 lbs. per foot is stretched between two points in the same horizontal plane. The length of the cable is 600 feet and the tension at the points of support is 2,000 lbs. Find the sag and also the distance between the points of support.

4. Explain clearly what do you understand by Instantaneous centre.

A rigid body has plane motion. Three points on the body A, B, and C in the same plane, are such that AB=3 feet, BC=2 feet, and AC=2.6 feet. At a certain instant it is known that the point A has a velocity of 4 feet per second in the direction from A to C, and the point B is moving in the direction from C to B. Show how the velocity of any other point on the body may be obtained and determine the values for the velocities of B and the point midway between A and B.

5. Find an expression for the kinetic energy of a body moving, in two dimensions.

A projectile weighing 12 lbs. has a linear velocity of 2,500 feet per second and an angular velocity about its axis of 500 revs. per second. If its radius of gyration is 0.75 inch, what is the total K.E. of the projectile?

6. Define Simple Harmonic Motion.

A vertical helical spring, whose weight is negligible, extended one inch by an axial Pull of 100 lbs. A weight of 250 lbs. is attached to it and set vibrating

axially. Find the time of a complete vibration. If the amplitude of the oscillation is 2 inches, find the Kinetic Energy when the weight is $\frac{2}{3}$ inch below the central position.

7. Solve the equations:—

(*a*) $(1+x^2)dy-(xy+x+x^3)dx=0$

(*b*) $(x^2+y^2)dx-2xy\,dy=0$

(*c*) $\frac{d^2y}{dx^2}+y=x.$

8. Explain clearly what you understand by the adiabatic expansion of a perfect gas and find an expression for the work done during an adiabatic expansion.

10 cubic feet of air at 75 lbs. pressure per square inch, expands adiabatically to 30 cubic feet. Find the work done.

9. What is meant by a temperature-entropy diagram for steam.

Explain how you would construct it. Deduce a formula for the efficiency of a steam engine working on the Rankine cycle.

10. An Engine of 520 H.P. takes in steam at 360°F. and exhausts it at 140°F. The steam used per hour is 3,200 lbs. Find the work per lb. of steam and find also the steam per hour that would be used by an engine of the same H.P. working on the Rankine cycle between the same temperature limits.

11. State what is meant by Carnot's cycle as applied to a perfect heat engine. What is meant by the efficiency of an engine? Give, also an idea as to how Carnot's cycle is arrived at.

Intermediate Science (Engineering), Part II, 1926.

Subject:—APPLIED MECHANICS.

Paper-setter—Prof. R. Stanfield, M.Inst.C.E., M.I.Mech.E., F.R.S. (Edin.).

Examiner—Prof. L. D. Coueslant, B.Sc. (Lond.).

Time—Three Hours. Full Marks—100.

SIX QUESTIONS ONLY TO BE ATTEMPTED.

1. A steam turbine rotor weighs 5,400 lbs., and is supported by two bearings, A and B, 80 inches apart, centre to centre; the centroid of the rotor being 30 inches from the centre of the bearing B. If the centroid is found to be 0.008 inches from the centre line of rotation, find the pressure produced on each of the bearings A and B, by the imbalanced centrifugal force, at a speed of 1,800 revolutions per minute.

2. An electric tramcar, weighing 11.2 tons, has a tractive resistance of 30 lbs. per ton. When it is travelling at 12 miles per hour down a gradient of 1 in 56, it is brought to rest by means of a force of 530 lbs. applied through the hand brake.

   Calculate the distance travelled by the car, before stopping, from the point where the brake is first applied.

3. A screw-jack has a square-threaded screw, with a mean diameter of 2 inches; the pitch being 0.5 inch. If the coefficient of friction is 0.2, what force acting at the end of a lever 24 inches long, measured from the axis of the screw, will just raise a load of 4 tons?

   What is the efficiency of the screw?

4. Water issues from a nozzle 1.5 inch in diameter with a velocity of 50 feet per second, and impinges against a flat plate at right-angles to the path of the jet.

   Calculate the pressure produced on the plate if the latter is (*a*) stationary, (*b*) moving with a velocity of 20 feet per second in the same direction as the jet. Assume in each case that all the water leaves the plate at right-angles to its original direction.

5. What is Simple Harmonic Motion?

   Write down expressions for the velocity and acceleration, at any point of the path, of a body describing a simple harmonic motion, stating clearly the meaning of each symbol used.

   A point describing a S.H.M. on a path of 30 inches is found to have a velocity of 8.4 feet per second when at a distance of 6 inches from the end of the path.

   Calculate the number of complete vibrations the point will make per minute.

6. A two-cylinder double-acting steam engine develops 125 indicated horse-power at a mean speed of 84 revolutions per minute, and the fluctuation of energy is 0.76 per cent. of the work done per stroke. The flywheel weighs 1,100 lbs., and has a mean diameter of 51 inches.

   Detemine the percentage cyclic speed variation above and below the mean speed.

7. What do you understand by the ' momentum ' of a body, and in what units is it measured?

   The tup of a drop-forging machine weighs 1.5 tons, and falls freely from a height of 90 inches. If it rebounds from the metal at 20 per cent. of the velocity of striking, and the duration of impact is one-twentieth of a second, calculate the average force of the blow produced.

8. A solid wrought iron shaft, 10 inches in diameter, is to be replaced by a hollow steel shaft of the same external diameter; the torsional strength of the two shafts being the same. Assume that the safe working stress in the steel is 35 per cent. greater than the stress allowed in the wrought iron.

Find the internal diameter of the hollow shaft, and the percentage saving in weight by the substitution.

If the shear stress in the steel shaft is limited to 8,000 lbs. per square inch, what horse-power will be transmitted at a speed of 80 revolutions per minute?

Intermediate Science (Engineering), Part II, 1926.

Subject:—HEAT ENGINES.

Paper-setter—Prof. R. Stanfield, M.Inst.C.E., M.I.Mech.E., F.R.S. (Edin.).

Examiner—Prof. L. D. Coueslant, B.Sc. (Lond.).

Time—Three Hours. Full Marks—100.

SIX QUESTIONS ONLY TO BE ATTEMPTED.

1. The cylinder of a Diesel engine is 16 inches in diameter; the stroke being 21 inches. At the beginning of the compression stroke the pressure of the air is 20 lbs. per square inch absolute, and the temperature is 68°Fah. The pressure at the end of compression stroke is 480 lbs. per square inch absolute.

Assuming the compression to be according to the adiabatic law, find (*a*) the clearance volume of the cylinder, and (*b*) the temperature at the end of compression.

2. Determine the cylinder diameters for a compound condensing engine to develop 120 B.H.P. with a piston

speed of 650 feet per minute, and a mechanical efficiency of 80 per cent. The initial steam pressure in the H.P.C. is 120 lbs. per square inch absolute, and the back pressure in the L.P.C. is 3 lbs. per square inch absolute. The valve in the H.P.C. is set to cut off the steam at half stroke, and the clearance fraction in each cylinder is 8 per cent. Diagram factor, 0.72. Cylinder volume ratio, 1 to 3.5.

3. The following particulars are taken from a test of a boiler:—

Feed water evaporated per hour, lbs.	6,000
Temperature of feed water, deg. Fah.	122
Temperature of steam, deg. Fah.	373
Latent heat of steam, B.Th.U. per lb.	857
Quality of steam	0.97
Calorific value of fuel, B.Th.U. per lb.	14,400
Efficiency of boiler, per cent.	70

Calculate the weight of coal used per hour.

4. A steam engine is fitted with a simple slide valve; the steam and exhaust laps being 1⅜ inches and ⅝ inch respectively. If the angle of advance is 34 degrees, and the lead 3/16 inch, what is the travel of the valve, and the maximum opening of port to steam?

Give the position of the crank at the four critical points.

5. During a B.H.P. test of a four-stroke cycle Semi-Diesel oil engine, in which the fuel was injected by air pressure, the following data were obtained:—

Duration of test, minutes	74
Load on brake, lbs.	90
Spring balance reading, mean, lbs.	4
Speed, revs. per minute, mean	302
Fuel oil used during test, lbs.	6.5
Effective diameter of brake wheel, inches	45.5
Specific gravity of fuel oil used	0.895
Cost of fuel oil, pence per gallon	6¼
Lower calorific value of fuel oil, B. Th.U. per lb.	18,000

Calculate from the above:—

(*a*) The B.H.P. developed.

(*b*) The oil used per B.H.P. per hour.

(*c*) The cost of running per B.H.P. per hour.

(*d*) The brake thermal efficiency of the engine.

6. Describe the sequence of operations of an engine working according to the Carnot cycle, and state why this engine has a higher efficiency than any other engine working between the same temperature limits. Upon what factors does a high efficiency depend?

A heat engine receives its fluid at 350°Fah., and discharges it into a condenser at 110°Fah. It consumes 200 B.Th.U. per horse-power per minute; compare its efficiency with that of the corresponding Carnot cycle.

7. Sketch and describe the general arrangement and construction of a surface condenser and air-pump suitable for use in conjunction with a steam turbine. How are the tubes connected to the tube plates?

Explain why it is necessary to have two air-pumps in certain turbine plants.

Why is it more important to have a good vacuum with a turbine than with a reciprocating engine?

8. Describe the principle of action in an oil-engine of the solid-injection type, working on the dual-combustion cycle.

Illustrate your answer by means of a sketch of the cylinder of such an engine in longitudinal section, showing the necessary valves.

How is the supply of fuel oil to the cylinder regulated?

What are the relative advantages and disadvantages of solid-injection as compared with air-blast injection?

Intermediate Science (Engineering), Part II, 1926.

Subject:—MECHANICAL DRAWING.

Examiners—Principals F. Walford, Wh.Sc., M.I.M.E.; C. A. King, B.Sc., A.R.C.Sc.

Time—Four Hours. Full Marks—100.

QUESTION ONE MUST BE ATTEMPTED.

1. The accompanying drawing represents a Locomotive connecting rod end. Draw the two views shown in the drawing and add an *end elevation*, looking in the direction of the arrow "A." *Scale* $\frac{3}{8}$ *Full Size.*

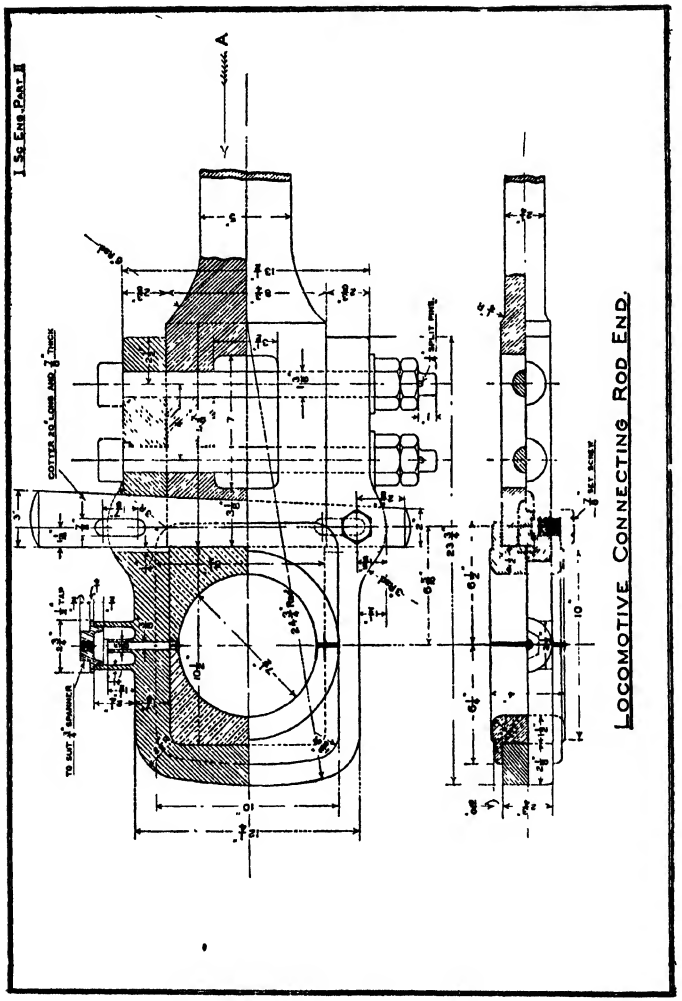
   Note, on your drawing, the materials of which the several parts should be made.

2. State how the brasses of the connecting rod end of question 1 are to be adjusted to take up the wear, and also explain the use of the shallow grooves cut in the cotter.

3. What object is attained by the use of a piston valve? Explain clearly its action in regulating the passage of steam to and from the cylinder. Sketch the valve.

4. Sketch a double-parted slide valve and explain the object of making it so.

5. Show by sketches how you would attach the valve to the spindle of a screw down stop valve so as to permit the screw to rotate independently of the valve.



Question 1.

Intermediate Science (Engineering), Part II, 1926.

Subject:—PRACTICAL GEOMETRY.

Paper-setter and Examiner—J. Tullis, B.Sc., M.I.E.S.

Time—Four Hours. Full Marks—100.

ANSWER FOUR QUESTIONS ONLY.

1. Fig. 1 shows the plan of the flanged end of a $1\frac{3}{4}$ inches dia. rod, the minimum thickness of the flange being 1 inch. The rod is joined to the flange with a turned radius of 1 inch. Draw an elevation of the flat side of the flange.

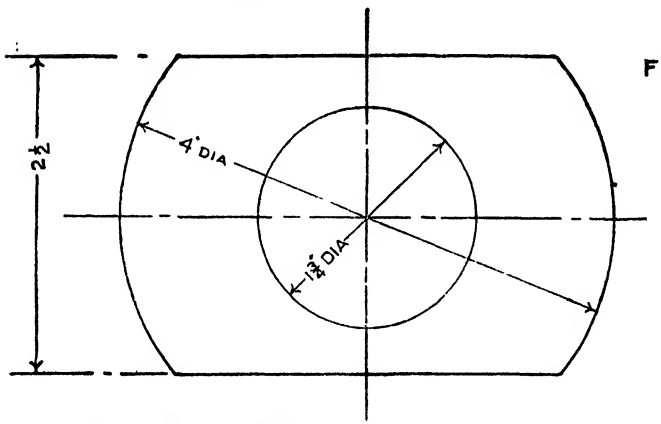


FIG. 1.

2. The diagram (Fig. 2) shows the plan of a pentagonal pyramid of 3 inches height, whose base lies on the H.P., and also the elevation of an equilateral triangular prism of indefinite length lying perpendicular to the V.P. Draw complete plan and elevation, showing the intersection of the prism with the pyramid.

   Find also the true shape of the face A of the pyramid showing the portion cut away by the prism.

3. Two parallel cylinders whose elevations are as shown in Fig. 3 (the axes being horizontal) are connected together by part of the tangent cone, the axis of the cone being at right-angles to the axes of the

cylinders. Draw a plan of the composite solid, and develop the surface of the conical connection.

FIG. 2.

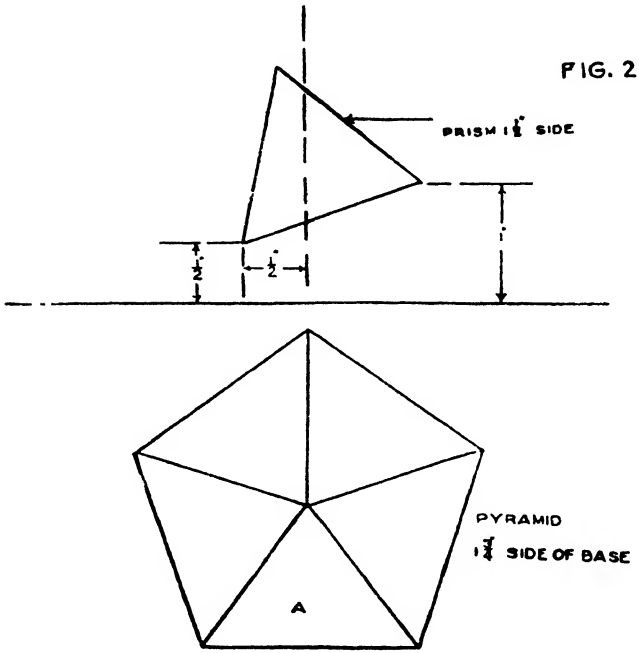
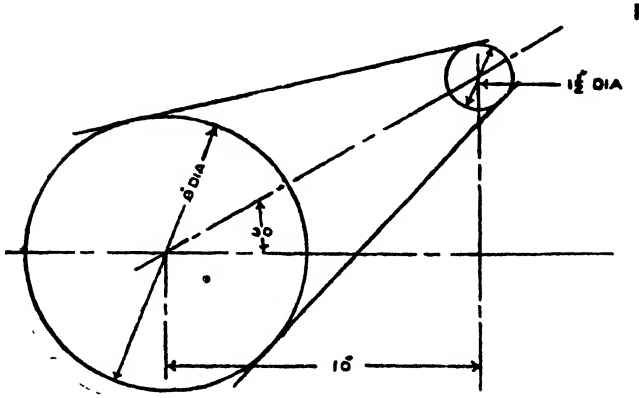


FIG. 3.



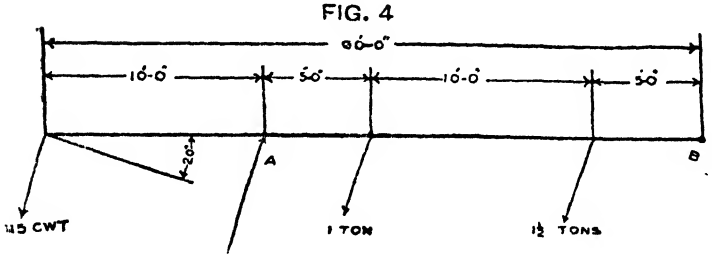
4. Find the profile of a cam to raise a tappet, having a roller 2 inches diameter, through 2 inches lift, the motion being S. H. M. Rise takes place in ¼th revolution, then rest for 1/12th revolution, and fall during the next ⅓rd revolution of the cam.

   Diameter of the cam shaft = 2 inches, least thickness of of metal = 1 inch. The line of action of the tappet passes through the cam centre, and the cam rotates with uniform angular velocity.

5. A Pratt Truss of 80 feet span and 12 feet high, is divided into eight equal panels and is loaded uniformly at 2,000 lbs. per foot run. Draw the stress diagram and show the members in compression.

6. A 30 feet girder is hinged at B and simply supported at A. The loading is as shown in Fig. 4. Draw the B. M. and S. F. diagrams.

FIG. 4



Intermediate Science (Engineering), Part II, 1926.

Subject:—ELECTRICAL ENGINEERING.

Examiners—H. Burkinshaw, M.I.E., M.I.E.E., etc., and Prof. B. C. Chatterjee, B.A., B.L., B.Sc., M.I.E.E.

Time—Three Hours. Full Marks—100.

ANSWER ANY SIX QUESTIONS.

1. In a 50-cycle A.C. lamp magnet, the stroke is 5 cms., the voltage, consumed at the constant alternating current of 5 amps., is 10 in the initial position, and 25 in the final position. Find the average pull of the magnet.

2. What do you mean by Eddy Current? Describe with the help of sketches the various methods of minimizing Eddy Current Loss and state some of its uses.

3. Find the watts lost due to (*a*) hysteresis, (*b*) eddy current in a transformer of 8,000 cubic centimetres, in which B=5,000 gausses, f=50, and the hysteretic constant $h=20\times10^{-11}$ watts per cubic centimetre per cycle; the laminæ are 12 mils thick.

4. The voltage of an over-compounded generator rises from 500 volts at no-load to 550 volts at full-load of 250 amperes. This generator supplies energy over a line of 0.25 ohms., resistance to a load that increases uniformly from 50 amperes to 250 during the first two hours of the day, then remains constant at 250 amperes for 5 hours and then decreases uniformly to zero during the last 3 hours. What is the total line loss per day? What is the all-day efficiency of transmission?

5. A 225-volt D.C. shunt motor when running light, *i.e.*, with no-load except the losses in the armature, takes an armature current of 10 amperes and rotates at a speed of 600 r.p.m. What will be its speed when the output is 45 H.P.? The losses in the field may be neglected and the resistance of the armature taken as 0.025 ohm.

6. In a two-phase interconnected supply the load on the leading phase is non-inductive, and amounts to 12 amperes, while that on the other phase takes a current of 14 amperes, lagging by 45°.

   (*a*) Find the current in the common wire in magnitude and phase.

   (*b*) Find the current if the loads are reversed.

7. Show with the help of a switchboard diagram how you will run two 3-phase alternators in parallel.

8. What do you understand by hunting of alternators? What are the remedies for such hunting?

9. What is the inductance of the field of an 8-pole alternator, if the 8 field spools are connected in series; each spool contains 500 turns, and a current of 5.65 amps. produces 6 megalines per pole?

10. Deduce the equation for determining the capacity of a transmission line with two-line wires.

B. Sc. Examination (Engineering), Part I, 1926.

SESSIONAL PAPER.

The paper is given to Candidates immediately after the Durga Pooja Holidays. The completed designs must be given to the Principal of the Engineering College on or before March 1st, 1926. The designs must satisfy the following specifications:—

Group I.—STRUCTURAL DESIGN.

Paper-setter—L. D. Coueslant, Esq., B.Sc., A.M.I.M.E.

Examiner—J. Tullis, Esq., B.Sc., M.I.E.

Design and working drawings are required of a round steel tank to hold 20,000 gallons of water with its lowest point 40 feet above ground. It is to be supported on a steel structure which must rest on a sufficient foundation in Gangetic clay.

Group II.—MECHANICAL DRAWING.

Paper-setter—L. D. Coueslant, Esq., B.Sc., A.M.I.M.E.

Examiner—J. W. Gaunt, Esq., A.M.I.M.E.

A complete schedule is required of the limit gauges required for the mass production of the Engine designed in Group III, also drawings, and design of all jigs, templates and fixtures in pictorial projection.

Group III.—HEAT ENGINES.

Paper-setter—L. D. Coueslant, Esq., B.Sc., A.M.I.M.E.

Examiner—J. W. Gaunt, Esq., A.M.I.M.E.

Design and drawings are required of a single cylinder horizontal steam engine 6 inches diameter by 9 inches stroke with cut off variable between $\frac{1}{4}$ and $\frac{3}{4}$ stroke, by hand adjustment while engine is running. Maximum cyclical speed variation 1/100, maximum total speed variation (controlled by a crankshaft governor which must be designed and drawn) 1/20. The engine is to be non-condensing with engine stop valve pressure 60 lbs. per sq. in. (gauge). A belt pulley to take off the maximum power is required. Speed 400 r.p.m.

Group IV.—ELECTRICAL ENGINEERING.

Part A.

Examiners—S. Ghosh, Esq., M.I.E.E., M.I.E.; B. C. Chatterjee, Esq., B.A., B.L., B.Sc., M.I.E.E.

Make a preliminary design of and estimate the cost of an Electrical Power and Light Supply for the City of Serajganj. The plan may be consulted in the office of the Professor of Electrical Engineering.

Part B.

Examiner—R. S. Jain, Esq., B.Sc., A.M.A.I.E.E.

Design and prepare complete working drawings of a direct current, interpole, motor of a semi-enclosed, continuous rating type, suitable for working in a carpenter's shop:

Capacity 25 B.H.P. at 1,150 R.P.M. and 500 Volts.

Maximum temperature rise after 8 hours' run on full load not to exceed 35°C.

Overload capacity 25 per cent. for two hours. The maximum temperature rise not to exceed 50°C. even when the 2 hours' overload follows immediately on an 8 hours' run at full load.

The bearings to be of self-lubricating type.

Insulation test to be 1,500 A.C. volts at 50-cycle for one minute.

B.Sc. Examination (Engineering), Part I, 1926.

Subject:—STRENGTH OF MATERIALS.

Paper-setter and Examiner—Prof. T. E. Dodds, Wh.Sch., B.Sc. (Lond.), A.M.I.C.E., A.M.I.N.A.

Time—Three Hours. Full Marks—100.

NOT MORE THAN FIVE QUESTIONS TO BE ATTEMPTED.

1. A plate spring is 30 inches long and consists of plates $2\frac{1}{2}$ inches wide by 5/16 inch thick. The central load is 1,000 lbs., the maximum safe working stress is 15 tons per sq. inch, and $E = 30 \times 10^6$ lb. per sq. inch. Calculate the number of plates required.

2. Calculate the diameter of a solid steel shaft to transmit 1,000 horse power at 500 r.p.m. The maximum shear stress must not exceed 3 tons per sq. inch and the modulus of rigidity is 12×10^6 lb. per sq. inch. Determine the angle of twist on a 6-feet length.

3. Sketch the stress strain curve you would expect from a mild steel specimen tested in tension to failure. Mark on your curve "E," elastic limit, and yield point.

   Describe the effect of overstrain of the specimen on the shape of this curve.

4. Sketch and describe a machine for determining ultimate shear stress.

5. Given a diagram showing the distribution of the load on a simply supported beam. Show by means of sketches how you would obtain the shearing force, bending moment, slope, and deflection diagrams.

6. Define " principal stresses." A solid shaft, 10 inches diameter, withstands a bending moment of 25 feet tons and a twisting moment of 10 feet tons. Calculate the maximum tensile, compressive, and shear stresses in the shaft.

7. Give a specification for mild steel to be used for structural purposes and indicate the tests you would apply before taking delivery.

8. A square bar of steel, $1\frac{1}{2}$ inches side, 10 feet long, is bent into a circular arc of 125 feet radius. Calculate the bending moment at the ends of the bar and the amount of strain energy stored in the bar.

B.Sc. Examination (Engineering), Part I, 1926.

Subject:—THEORY OF STRUCTURES.

PAPER I.

Paper-setter and Examiner—Prof. T. E. Dodds, Wh.Sch., B.Sc. (Lond.), A.M.I.C.E., A.M.I.N.A.

Time—Three Hours. Full Marks—100.

NOT MORE THAN FIVE QUESTIONS TO BE ATTEMPTED.

1. By means of the method of Sections describe how you would calculate the forces in the members of an N girder loaded at the pin joints of the lower boom.

2. A simply supported beam has a span of 20 feet and supports concentrated loads of 5, 10, and 8 tons at 6, 11, and 13 feet, respectively from the left hand end and also a uniformly distributed load of 2 tons per

foot run beginning at 4 feet from the left hand end and extending 11 feet along the beam. Draw the shearing force and bending moment diagrams.

3. A steel I section has a depth of 12 inches and its flanges are each 5 inches wide and 1 inch thick. The web is $\frac{3}{4}$ inch thick. It is used as a column of height 9 feet, fixed at both ends. Determine the safe axial load for this column.

4. Describe how you would proceed to design the purlins and the members of a roof truss, given the dead and wind loads, the span and spacing of the trusses. .

5. Design the central cross section of a plate girder for a clear span of 60 feet and a uniformly distributed dead load of 2 tons per foot run, inclusive of the weight of the girder. Calculate the rivet pitch in the vicinity of the ends of this girder.

6. Derive an expression for the deflection at the end of a cantilever loaded with a concentrated load at that point.

A cantilever 10 feet long, moment of inertia about the neutral axis 145.6 inches^4, supports a concentrated load of $3\frac{1}{2}$ tons at the end. Calculate the strain energy due to bending stored in this cantilever.

7. A masonry dam of rectangular section is 12 feet high and the water-level is 2 feet below the top of the dam. Calculate the width of the dam so that there shall be no tensile stress at the base. One cubic foot of masonry weighs 150 lbs.

8. Two concentrated loads of 8 tons each and 7 feet apart move across a bridge of 60 feet span. Draw the curves of maxima bending moments and shearing forces.

B.Sc. Examination (Engineering), Part I, 1926.

Subject:—THEORY OF MACHINES.

Paper-setter and Examiner—Prof. L. D. Coueslant, B.Sc. (Lond.), A.M.I.M.E., M.I.E.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

1. A rigid link is 6 inches long, one end (A) moves with uniform velocity in a circle one inch in diameter at 100 revolutions per min. and the other (B) on a tangent to the circle.

   Find the velocity and acceleration of B at a point midway in its stroke approaching the circle.

2. A pinion of 10 teeth which has been driving a wheel of 80 teeth for several years is quite worn out, the wheel being almost as good as new. How can this be? Why would a new pinion to the original drawing be unsatisfactory?

   Describe how you would find a suitable profile for the new pinion.

3. A ball bearing on a line shaft is composed of two rows of balls one quarter of an inch in diameter with twenty balls in each row. What would be the safe working load on it?

4. A belt which weighs 0.25 lb. per foot of its length connects two pulleys each four feet in diameter, and when at rest presses upon them with a force of 3 lbs. per inch of length of the belt. If the pulleys are speeded up without transmission of power, find at what speed the pressure will vanish. Find also the final and initial tension on the belt.

5. A governor of the Hartnell type at normal speed of 400 revolutions per minute has the balls each weighing 2 lbs., vertically below the pivot. The radius of the ball centre is then 8 inches. Both arms of the bell crank are of the same length. The throttle valve is required to be completely closed when the governor sleeve moves half an inch, and the speed rises to 440 revolutions per minute. Find dimensions of the spring.

6. Write a short essay with sketches on " The Machines of My Village." Descriptions of, and comments on, from the Engineer's point of view, are required of the machines habitually used from ancient times.

7. The two crank webs of a forged crank shaft are each 2 inches, by 4 inches, by 8 inches, the throw being 5 inches and the crank pin 3 inches in diameter. Of the connecting rod which weighs 60 lbs. two-thirds may be supposed concentrated at the crank pin centre.

   Design and sketch a pair of cast iron balance weights, showing mode of attachments.

8. An eccentric of throw equal to 1 inch and diameter 6 inches is used as a cam driving a push rod which moves on a line passing through the centre of rotation. The roller is 2 inches in diameter. Show that as far as velocity and acceleration are concerned this is equivalent to the ordinary engine mechanism. Find the maximum velocity of the push rod, and its accelerations at the ends of its stroke if the eccentric makes 500 revolutions per minute.

B.Sc. Examination (Engineering), Part I, 1926.

Subject:—HYDRAULICS.

Paper-setter and Examiner—C. A. King, B.Sc., A.R.C.Sc., M.I.M.E., M.I.S.E., M.I.E.

Time—Three Hours. Full Marks—100.

ANSWER SIX QUESTIONS ONLY.
THE QUESTIONS ARE OF EQUAL VALUE.

1. Describe a modern form of Hydraulic Dynamometer for measuring and absorbing the energy developed by a prime mover at a rotating shaft.

2. One of the problems to be considered in connection with the Hydraulic Crane is the supply and discharge of water to and from the cylinder of the crane. How is this arranged when the supply pressure is very high? What are pilot valves?

3. 100 B.H.P. is required from a hydraulic motor having an efficiency of 75 per cent. The motor is two miles from the generating station and only a single six-inch pipe line is available. The pressure at the station being 1,120 lbs. per sq. inch, determine the pressure at the motor, the efficiency of transmission and the velocity of flow.

4. Describe briefly the "Air Lift Pump" and explain its action. Develop the theory of the pump and deduce a formula for its efficiency assuming isothermal compression and expansion of the air used.

5. Determine the maximum horse-power which can be transmitted through a 6-inch pipe two miles long ($f=.01$) if the inlet pressure is 750 lbs. per square inch. Also determine the pressure at the outlet, and the velocity of flow when this power is being transmitted.

6. In an outward-flow turbine the speed of flow from the guides is 40 feet per second, the guide vane angle is 20° and the wheel vane angle is 90°. The outer diameter is $1\frac{1}{2}$ the inner, and the final (radial) velocity of discharge is 15 feet per second. Determine the wheel angle at outlet and the work done per lb. of water used. Is this turbine of the reaction or impulse type? If the former, determine the pressure-head at inlet to the wheel if that at outlet is atmospheric, and also the working head and efficiency. Neglect frictional losses.

7. 100 horse-power is to be obtained from a Pelton wheel, the efficiency of which may be taken at 80 per cent. The surface water level in the reservoir is 300 feet above the wheel, the supply pipe is 3 miles long, and the fall of pressure-head in the pipe is 10 feet per mile. Taking $f = .0075$ for the pipe and the coefficient of velocity of the nozzle as 0.94, find the diameters of the nozzle and of the pipe.

8. Determine the leading dimension, speed of rotation, hydraulic efficiency, and probable H.P. required to drive a centrifugal pump which shall deliver 5 cubic feet of water per second against a working head of 60 feet.

9. Write a short essay on the reciprocating pump with special reference to its efficiency and discharge. Draw and explain the pump diagrams for suction and delivery. What is meant by cavitation and hammer pressure?

B.Sc. Examination (Engineering), Part I, 1926.

Subject:—HEAT ENGINES.

Paper-setter and Examiner—C. A. King, B.Sc., A.R.C.Sc., M.I.M.E., M.I.S.E., M.I.E.

Time—Three Hours. Full Marks—100.

ANSWER SIX QUESTIONS ONLY.

ALL QUESTIONS ARE OF EQUAL VALUE.

1. State the thermodynamic principle involved in the design of a counter current condenser. Sketch a condenser of this type in sufficient detail to explain the application of the principle in practice.

2. The practical qualities of a governor are:—

   (1) Sensitiveness, (2) effort, (3) power, (4) stability.

   Define each of these terms and compare the Watt, the Porter, and the spring loaded governor in respect of each of these qualities.

3. Forty cubic feet of air at a temperature of 30°C. and a pressure of 40 lbs. per square in. abs. are compressed to a pressure of 160 lbs. per square in. abs.

   Find the quantity of heat which must be taken from the air during the process if the compression is (*a*) isothermal, (*b*) according to the law $P.V^{1.2} = \text{constant}$

4. To what extent is the efficiency of a turbine affected by the use of superheated steam; and by a high vacuum condenser?

   Sketch and describe briefly some form of turbine governor.

5. Sketch in section any well-known make of carburettor and explain the principle of its action.

6. Explain the reasons for arranging an air compressor so that the work of compression is done in two or more stages when high pressures are required. Determine the best division of the work between each stage in a two stage air compressor.

7. An impulse turbine of the Curtis type has two stages each with one set of nozzles, three rotating and two fixed sets of blades. Steam at 160 lbs. per square in. and 100°C. superheat is expanded in the first stage down to 20 lbs. square in. The rotating blades have a circumferential speed of 500 feet per second and have entrance and exit angles of 30°. Neglecting friction, draw the velocity diagram for the stage and find the entrance and exit angles of the fixed blades and the inclination of the nozzles.

   Determine the horse-power developed in the stage per lb. of steam flowing through the turbine per second.

8. A four-stroke cycle oil engine, cylinder diameter 8½ inches, stroke 16 inches, gave the following results in a test. Mean effective pressure 60 lbs. per square inch; brake load, at a radius of 2 feet, 103 lbs.; revs. per minute 225; explosions per minute 104; oil per hour 9.3 lbs.; calorific value of oil 10,200 C.H.V. per lb. Calculate (*a*) the I.H.P. and B.H.P., (*b*) the oil per hour per I.H.P. and B.H.P., (*c*) the thermal efficiency. Indicate by a sketch how an engine of this type might be governed.

9. Sketch and describe a refrigerating machine capable of producing about 2 tons of ice in eight hours during the hot season in India.

B.Sc. Examination (Engineering), Part I, 1926.

Subject:—ELECTRICAL ENGINEERING.

Paper I (Part I).

Examiner—B. C. Chatterjee, B.A., B.L., B.Sc., M.I.E.E.

Time—Three Hours. Full Marks—100.

Answer any SIX Questions.

1. What do you mean by the Synchronizing power?

   Two 400-kv.-a. alternators each running as a single-phase machine and each having a voltage of 2,300 volts were thrown in parallel, when they were at what was believed to be the correct phase relation, that is, the e.m.f.'s were supposed to be 180° apart. Generator A, however was 25° ahead of this correct 180° position with regard to generator B. Each generator has a 10 per cent. inherent reactance and a 2 per cent. resistance. Which generator delivers synchronizing power to the other, and how great is this power?

2. What size generator, in kv.-a. (kilovolt-amperes), is required to supply a system comprising induction motors taking 64 kilowatts at 80 per cent. power-factor, incandescent lamps taking 40 kilowatts at 100 per cent. power-factor, and idle transformers taking 5 kv.-a. at 40 per cent. power-factor. For simplicity, assume these values to include the power used to overcome losses and reactions in the corresponding distributing wires and determine the power-factor of the total load.

3. The machines in a certain shop are arranged in three groups, driven by line shafts connected to three similar 50-h.p. alternating-current motors. One of

these operates at half load, with an efficiency of 86 per cent. and power-factor 75 per cent. The second operates at $\frac{3}{4}$ load, efficiency 88 per cent. and power-factor 83 per cent. The third operates at full load, with efficiency of 89 per cent. and power-factor 88 per cent. Calculate the kw., reactive kv.-a., and total kv.-a. supplied to each motor, and to the entire shop. Calculate also the power-factor of the feeder supplying this shop.

4. The load on a 2,300 volt three-phase line consists of 2,000, $\frac{1}{2}$ amp., 120 volt lamps on three circuit, and 300 h.p. of three-phase motors with an average power-factor of 80 per cent., and an average efficiency of 86 per cent. all on one circuit. Draw the diagram of connections, specify the transformers, and find the current in the mains and also the resultant power-factor.

5. The normal power-factor of a system is 0.75 and the full designed load of 1,000 kv.-a. is being handled. It is desired to connect more 0.75 power-factor load to the system so that 950 kw. can be handled, by installing condensers so that the power-factor of the new total load shall be raised to 0.95. Calculate the necessary capacity at 6,600 volts, 50 cycles per sec.

6. A transmission line has resistance of 14 ohms and a reactance of 1.8 ohms. at 60 cycles. The station voltage is 13,200 and a load at the end of the line takes 750 kw. at a power-factor of 0.85 (lagging current). What is the current? What is the voltage at the load?

7. Find the apparent input, in KVA, of a 25-h.p., three-phase motor supplied at 220 line volts, if its efficiency is 87 per cent., and its power-factor 91 per cent. at that load. Also find the full-load line current, and the phase current, assuming the machine to be mesh-connected.

8. In a certain moving-coil instrument, 0.05 of a volt is sufficient to produce a full scale deflection. It is proposed to use the instrument to indicate a maximum current of 200 amperes. If the shunt be made from manganin strip 0.6 millimetre thick, calculate the dimensions of the shunt. Specific resistance of manganin=43 microbes per centimetre cube.

9. A voltmeter of 20,000 ohms resistance gave the following readings:—

Between mains 220 volts.

Positive mains to earth 127 volts.

Negative mains to earth 43 volts.

(1) Find the insulation resistance to each main.

(2) If the negative main is earthed through an ammeter what will be the reading on the instrument?

(3) If neither main is earthed what is the leakage current?

10. Describe in detail how you charge a secondary battery for the first time.

11. A battery has been badly sulphated, state the probable causes and suggest the remedies.

B.Sc. Examination (Engineering), Part I, 1926.

Subject:—ELECTRICAL ENGINEERING.

PAPER I (PART II).

Paper-setter and Examiner—T. H. Matthewman, M.Eng., M.I.E.E.

Time—Three Hours. Full Marks—100.

SIX QUESTIONS ONLY TO BE ATTEMPTED.

THE QUESTIONS ARE OF EQUAL VALUE.

1. A motor of 100 B.H.P. is required and you have the choice of purchasing one of the following:—

   A, costing Rs. 5,250; having an efficiency of 90 per cent.

   B, costing Rs. 3,750; having an efficiency of 88 per cent.

   C, costing Rs. 2,800; having an efficiency of 84 per cent.

   It is proposed to run the motor 8 hours per day, and the cost of running is based on a charge of Rs. 80 per annum per K.W. of maximum demand plus annas 2 per unit used. Which motor would you choose?

2. A 20 K.W. dynamo running on no load as a motor takes 2.8 amperes at 440 volts. The resistance of its armature is 0.5 ohm., and that of its field winding 770 ohms. Calculate its efficiency when running as a generator on half full load.

3. Describe the general characteristics of the direct current series machine (*a*) as a generator (*b*) as a motor. Why is the series generator unsuitable for charging a battery?

   Would it be suitable as a motor for driving a grinding machine?

4. Describe, with diagram, the construction and operation of a complete starter for a shunt wound motor.

   On starting an unloaded shunt motor it is found to race up in speed. Where would you look for the cause of this and why?

   What adjustment would you make if the handle of the starter swung back to the off position before the motor could develop its rated B.H.P.

5. Describe the necessary equipment for a works testing laboratory in order to keep ordinary direct current instruments calibrated.

6. Give a short description, with sketches, of the moving coil permanent magnet ammeter. Can this instrument be used for measuring alternating currents? Explain. In a certain instrument the moving coil requires a current of 0.025 ampere to produce a full scale deflection and its resistance is 2 ohms. Calculate the resistance of a shunt suitable for use with this instrument in order to measure 100 amperes.

7. Define the following terms:—(*a*) Mean spherical candle power (*b*) Lumen (*c*) Illumination. What is the illumination at the edge of a circular table 7 feet in diameter from a lamp of 100 C. P. placed 4 feet above the centre of the table?

8. (*a*) Describe a type of secondary cell suitable for rapid discharge and for use where there is considerable vibration.

   (*b*) When a battery is charged from a shunt wound generator driven by an oil-engine the ammeter needle fluctuates at every explosion, though the light of a lamp connected across it remains apparently steady. Explain this.

9. Explain clearly the disadvantages of a bad power factor on an alternating current system, and the reason why the machines are often rated in K.V.A. rather than K.W.

If a factory taking 120 K.W. at 240 volts from single phase mains, at a power factor of 0.6 lagging, wishes to raise its power factor to 0.9 lagging, what size of static condenser would accomplish this if the frequency of supply is 50 cycles per second.

10. Five 100-volt incandescent lamps are connected in parallel and supplied with alternating current. Each lamp takes 0.4 ampere. The supply voltage is 120, and a choking coil is used in series with the lamps to reduce the voltage. If the coil has a resistance of two ohms and an inductance of 0.05 henry, find the frequency at which it will give the required voltage drop. What is then the power factor of the circuit, and how much is the wattless current?

11. A combined power and lighting load is supplied by a 3 phase 4 wire distribution system. The 3 phase motor load absorbs 1,000 K.W. at a power factor 0.75, while lamps connected between the outers and neutral wire take 200, 300, 400 K.W. respectively. Calculate the current in each of the 4 wires, when the supply pressure between outers is 400 volts.

12. (*a*) Show that 3 phase alternating currents can be made to produce a uniformly rotating magnetic field.

(*b*) Explain carefully the differences between the properties of the squirrel cage and the wound rotor induction motors.

B. Sc. Examination (Engineering), Part II, 1926.

(Mechanical Branch.)

SESSIONAL PAPER.

The paper is given to Candidates immediately after the Durga Pooja Holidays. The completed designs must be given to the Principal of the Engineering College on or before March 1st, 1926. The designs should satisfy the following specifications:—

Group I.—STRUCTURAL DESIGN.

Paper-setter—L. D. Coueslant, Esq., B.Sc., A.M.I.M.E.

Examiner—J. Tullis, Esq., B.Sc., M.I.E.

The design and drawing of an ice factory capable of turning out ten tons of ice in 8 hours. The building must be of some architectural beauty and a perspective drawing of it is required. In this group the design and drawing of, a hand-operated traveller to lift blocks of ice weighing one cwt. are also required.

Group II.—HYDRAULIC MACHINES.

Paper-setter—L. D. Coueslant, Esq., B.Sc., A.M.I.M.E.

Examiner—J. W. Gaunt, Esq., A.M.I.M.E.

The evaporative condenser, brine tanks, still, pumps and all hydraulic connections are required to be designed and drawn for the factory of Group I above.

Group III.—MECHANICAL DRAWING AND MACHINE DESIGN.

Paper-setter—L. D. Coueslant, Esq., B.Sc., A.M.I.M.E.

Examiner—J. W. Gaunt, Esq., A.M.I.M.E.

An ammonia compressor with an oil engine to drive it for above factory.

B. Sc. Examination (Engineering), Part II, 1926.

Subject:—STRENGTH OF MATERIALS.

(Mechanical Branch.)

Paper-setter and Examiner—Prof. T. E. Dodds, Wh.Sch., B.Sc. (Lond.), A.M.I.C.E., A.M.I.N.A.

Time—Three Hours. Full Marks—100.

NOT MORE THAN FIVE QUESTIONS TO BE ATTEMPTED.

1. Deduce an expression for the shear stress at any distance from the neutral axis of a beam of rectangular cross-section for a total shearing force S across a vertical section.

   The total shearing force across an I section of depth 12 inches, width of each flange 5 inches and thickness 0.65 inch, and web thickness 0.44 inch, is 25 tons. Draw a diagram showing the distribution of shear stress and calculate the percentage of the shearing force taken by the web.

2. Sketch and describe a machine and the form of test specimen employed for impact tests. Discuss the value of such tests in relation to the heat treatment of steels.

3. Explain why it is necessary to insure axial loading when testing brittle materials in tension for ultimate strength, while a slight eccentricity of load in the case of plastic materials is of no great consequence.

   Deduce a formula to show the variation of stress due to a non-axial load, provided the maximum stress does not exceed the elastic limit of the material.

4. Describe the Brinell and the scleroscope hardness tests. In the case of a given brand of steel discuss the relationship between hardness and ultimate strength.

5. You are given a number of steel rods of various diameters and lengths. Explain in detail how you would obtain graphs showing the variation of the crippling load with (*a*) diameter and (*b*) length when these rods are used as pin ended struts.

6. Deduce an expression for the deflection at the load due to a concentrated non-central load on a simply supported beam. Use the principle of strain energy due to bending.

   Explain how this expression is utilised in the calculation of the critical speed of a shaft carrying a pulley at this point, the weight of the shaft being neglected.

7. Sketch and describe an instrument for measuring the contraction in length of a compression specimen. Explain the difference in the failure of ductile and brittle materials under compression.

8. A bar 1 inch diameter is to be tested in torsion. The shear stress must not exceed 5 tons per square inch, what is the maximum torque that may be applied?

   How would you measure the twist on a short length and proceed to obtain a series of results from which you could calculate the modulus of rigidity.

B. Sc. Examination (Engineering), Part II, 1926.

Subject:—THEORY OF STRUCTURES.

(Mechanical Branch.)

Paper-setter and Examiner—Prof. T. E. Dodds, Wh.Sch., B.Sc. (Lond.), A.M.I.C.E., A.M.I.N.A.

Time—Three Hours. Full Marks—100.

NOT MORE THAN FIVE QUESTIONS TO BE ATTEMPTED.

1. A girder 100 feet span freely supported at the ends supports a uniform dead load of 2 tons per foot run. A uniform live load of $2\frac{1}{2}$ tons per foot run, longer than the span, crosses the bridge. Draw the curves of maximum bending moment and shearing force.

2. A simply supported beam is loaded with a single concentrated central load. Derive an expression for the deflection under the load.

   A simply supported girder of I section 12 inches deep, width of flanges 6 inches, web thickness 0.6 inch, and flange thickness 0.8 inch, has a clear span of 24 feet and supports a concentrated central load of 5 tons. Calculate the deflection at the centre due to this load.

3. Two of the legs of a tripod are each 20 feet long and their lower ends are 10 feet apart. The third leg is 25 feet long and its foot is 11 feet from each of the feet of the other two legs. A load of 6 tons is suspended from the apex of the tripod. Calculate the forces in the legs.

4. A Warren girder consists of equilateral triangles and has 10 equal bays of 20 feet in the lower boom. There is a dead load of 40 tons at each pin joint in the lower boom. Determine the force in each member and suitable cross-sections for the three members cut by a vertical line 55 feet from one end.

5. Sketch and describe the method of reinforcing a concrete floor complete with cross beam, main beam and the attachment to a column.

6. A rolled steel joist of 40 feet span is fixed at the ends and supports a uniformly distributed load of 28 tons. Its depth is 24 inches and moment of inertia about the neutral axis is 2654.7 inches. The right hand end of the joist sinks $\frac{1}{2}$ inch, but both ends remain horizontal. Calculate the maximum tensile stress under these conditions and draw the bending moment diagram.

7. A three-pinned segmental arch has a span of 100 feet and a rise of 20 feet. A load of 1 ton passes over the arch. Plot a graph showing horizontal thrust in the arch against position of the load. Show how this graph can be used to determine the horizontal thrust produced by any system of loading.

8. A tension member 10 inches broad by 1 inch thick has to be connected to a gusset plate by two straps each 10 inches broad. Design this riveted joint to give maximum efficiency. State the efficiency and the maximum safe working load that the joint will withstand.

B. Sc. Examination (Engineering), Part II, 1926.

Subject:—HYDRAULICS.

(Mechanical Branch.)

Only Paper.

Paper-setter and Examiner—L. D. Coueslant, B.Sc. (Lond), A.M.I.M.E., M.I.E.

Time—Three Hours. Full Marks—100.

Attempt FIVE questions only.

1. An ordinary brick lined well in ordinary soil is 12 feet in diameter, the ground water level being 60 feet from the top of the well.

   What should this distance be when pumping to full capacity and what is the amount of water in gallons per hour that may safely be drawn?

   What would you expect to happen if it were exceeded?

2. With the aid of sketches suggest a method of increasing the yield of the above well by means of a tube sunk at the bottom. Under what circumstances would you attempt to establish a "Mota" well in order to save the cost of a strainer?

3. A box barge is 100 feet long, 15 feet wide and 10 feet deep. Unloaded it floats with 6 feet of its vertical side above the (fresh) water level. Find the load required to sink it a further 5 feet. If this load is distributed over the central 25 feet, find the maximum bending moment on the barge.

Describe an experiment that might be made in a laboratory to determine the coefficient of viscosity of oil. Prove Poisseuille's formula for viscous flow through a round pipe.

5. Water is flowing along a rectangular channel 20 inches wide, the depth of water being one foot. The end of the channel is provided with a right-angled triangular gauge notch and the difference of level between the lowest point of the notch and the surface of the water a short distance up stream is 9 inches.

Calculate the discharge in cubic feet per second and correct your result twice for velocity of approach.

6. Establish a rational formula connecting Horse-Power, Head, Speed, and Specific Speed of a water turbine. Use it to find a suitable running speed for a 1,000 K.W. set developing alternating current of periodicity 60 from a head of 70 feet. Select your own specific speed.

7. The areas of a Venturi Meter are 3 and 3.5 square feet. The difference of heads is three inches of mercury (uncorrected for water head). Correct it and estimate the discharge in cubic feet per second.

8. The loss of power by friction on the impeller of a turbine pump is proportional to the mth power of its diameter, and to the nth power of its speed (neglecting the radial velocity of the water). Find m and n by calculation. What influence has this result had on the design of the centrifugal pump?

B. Sc. Examination (Engineering), Part II, 1926.

Subject:—THEORY OF MACHINES.

(Mechanical Branch.)

Paper-setter and Examiner—Prof. T. E. Dodds, Wh.Sch., B.Sc. (Lond.), A.M.I.C.E., A.M.I.N.A.

Time—Three Hours. Full Marks—100.

NOT MORE THAN FIVE QUESTIONS TO BE ATTEMPTED.

1. By the construction of a diagram show how to determine the acceleration of the crosshead of a simple engine. Prove the accuracy of your construction.

2. Describe the method of finding the magnitude and position of the balance weights for an uncoupled inside cylinder locomotive. State and justify any assumption you make. Discuss the effect of adding a coupling rod.

3. Sketch and describe a Whitworth Quick Return mechanism. How is the ratio of cutting time to return time determined? Show by means of a velocity diagram how to obtain the velocity of the tool for any crank angle; also show this by means of instantaneous centres.

4. Sketch and describe the gear box of a motor car, or the steering mechanism, or a four wheel brake mechanism.

5. The steam turbine of a ship runs at 3,500 r.p.m. The rotor, shaft, propeller, etc., have an effective moment of inertia of 0.7 foot ton units. The ship can complete a circle in 15 seconds. Calculate the magnitude and direction of the couple acting on the hull. Prove any formula used.

6. Given the indicator diagrams for a double acting steam engine and full particulars of the engine, describe

how to determine the size of a flywheel to maintain the cyclical fluctuations of speed within a given percentage.

7. A thrust block collar has an external diameter of 12 inches, an internal diameter of 7 inches, and resists a load of 15 tons. The shaft runs at 100 r.p.m. and the coefficient of friction is 0.018. Calculate the horse-power absorbed in friction (1) if the pressure intensity is constant and (2) if the pressure is inversely proportional to the velocity of rubbing.

8. Show how to calculate the critical speed of a rotating shaft carrying pulleys. Prove any formula you use. Show the application of this method to determining the critical speed of a turbine rotor.

B. Sc. Examination (Engineering), Part II, 1926.

Subject:—HEAT ENGINES.

(Common for Mechanical and Electrical Branches.)

Paper-setter and Examiner—C. A. King, B.Sc., A.R.C.Sc., M.I.M.E., M.I.E.E., M.I.E.

Time—Three Hours. Full Marks—100.

ANSWER SIX QUESTIONS ONLY.
ALL QUESTIONS ARE OF EQUAL VALUE.

1. A gas engine has to develop 40 B.H.P. with an expected mechanical efficiency of 85 per cent., and a piston speed of 650 feet per minute.

   If the index n for the compression and expansion curves is taken as 1.32, and the maximum pressure of the explosion is 2.6 times the compression, determine the necessary diameter of the cylinder.

   Assume that the clearance volume is 27 per cent. of the volume swept by the piston, and that the diagram factor is 0.92.

2. Explain clearly why a high vacuum is essential for high efficiency in a steam plant. Sketch and briefly describe any one type of vacuum augmentor.

   The temperature of steam in a condenser is 52.3°C. and the pressure in the condenser is 2.25 lbs. per sq. inch absolute. Calculate the relative weights of steam and air in the condenser.

3. The volumetric percentage composition of gas supplied to a gas engine is CO 12.6, H_2 41.6, CH_4 26.6, CO_2 2.6, O_2 1.9, N_2 14.7 and the volumetric analysis of the dry exhaust gases is CO_2 8.53, O_2 4.9, N_2 86.57.

   Calculate the volume ratio of air to gas in the charge in the gas engine cylinder. Do you consider this charge to be a weak or a rich mixture.

4. Explain the advantages of a trip gear in cases requiring a very wide range of cut off. By means of carefully drawn sketches explain the action of the trip gear, and the mechanism by means of which the governor controls the point of cut off.

5. Steam at a pressure of 225 lbs. per sq. inch and superheated 50°C is throttled down to 180 lbs. per sq. inch at admission to a triple expansion engine and exhausted into a condenser at 3 lbs. per sq. inch. If the steam consumption is 14.5 lbs. per I.H.P. hour, calculate the efficiency ratio between the admission and the exhaust pressures, taking the Rankine cycle as the standard for comparison. Sketch the temp. entropy diagrams for each stage, assuming equal work done per stage.

6. Obtain the dimensions of a 3 stage air compressor to supply 12 lbs. of air per minute at 375 lbs. per square inch (absolute) with efficient cooling and intercooling. What power would be required to drive it?

7. Why are CO_2 and NH_3 the vapours that are most frequently used in refrigerating machines? Compare the advantages and disadvantages of these two vapours. Describe a machine using one of them.

8. Establish Clapeyron's Equation for the volume of a vapour, assuming Gibb's Function.

Select any three successive values of temperature, pressure, and latent heat from your steam tables and calculate the specific volume of steam for the mid-most pressure.

B. Sc. Examination (Engineering), Part II, 1926.

Subject:—ELECTRICAL ENGINEERING.

(Mechanical Branch.)

Paper-setter and Examiner—W. T. Maccall, M.Sc., M.I.E.E.

Time—Three Hours. Full Marks—100.

MARKS WILL BE GIVEN FOR ANSWERS TO NOT MORE THAN FIVE QUESTIONS. THE MAXIMUM FOR EACH IS 20.

1. Draw on squared paper typical external characteristics for (*a*) a shunt-wound generator; (*b*) an over-compounded generator; (*c*) a series-wound generator with drooping characteristic.

By drawing resistance (or conductance) lines in case (*c*) find the graph connecting current with conductance.

2. What are the effects of armature reaction on the field (*a*) in generators, (*b*) in motors?

Explain in detail how (*a*) interpoles, (*b*) carbon brushes, enable good commutation to be obtained with fixed brush lead and varying loads or varying speeds.

3. Plot the magnetic characteristic of a shunt-wound motor from the following figures:—
0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8; 1.0; 1.2 field amperes.
0.30; 0.44; 0.54; 0.62; 0.68; 0.73; 0.77; 0.84; 0.88 megaline per pole.

If the resistances of the windings are:—

Shunt 190 ohms; armature (including brushes) 0.8 ohm; and the supply P.D. is 220 volts, speed of motor with 20 amperes flowing in armature 600 r.p.m., find the resistances needed (*a*) to reduce the speed to 400 r.p.m.; (*b*) to raise the speed to 800 r.p.m.; with the armature current unchanged in each case.

Draw a diagram of connections for each case, and state the ratios of the torque and of the H.P. to the values at 600 r.p.m.

4. A shunt-wound motor designed for 250 volts is to be used unchanged on a supply at 200 volts.

Make a reasoned estimate of the probable percentage reduction in its full load torque, speed, and H.P.

If the magnets are re-wound what change of cross-section of the wire should be made? What will then be the full-load torque, speed and H.P. compared with their values on a 250-volt supply?

5. What type of instrument would you use for measuring each of the following:—

(*a*) a continuous current of 300 amperes; (*b*) an alternating current of 20 amperes; (*c*) an alternating pressure of 220 volts, frequency nearly constant; (*d*) the same with wide variation of frequency; (*e*) an alternating pressure of 3,000 volts; (*f*) an alternating pressure of 50,000 volts.

6 A three-phase motor if switched directly on to the full line pressure takes a starting current of 120 amperes from each line, and can start against 90 per cent. of full load torque.

If this motor is started by a star-delta switch what will be the starting currents in the motor windings and in the lines, and against what load can it start?

If it is started by an auto-transformer, using the 70 per cent. tapping, what are the starting currents and load?

In the latter case draw a diagram of connections during starting, and state the currents in the various parts of the auto-transformer windings.

7. A certain coil requires a P. D. of 200 volts at 50 cycles per sec. to send 5.7 amperes through it; an equal current is sent through the same coil by a steady P. D. of 130 volts. Find the impedance, resistance, and reactance of the coil.

How much current flows if the coil is connected to an A. C. supply at 200 volts, 25 cycles per sec.?

In the last case find the capacity needed to bring the power-factor to unity; and the value of the power-factor if the frequency is then raised to 50 cycles per sec.

8. Three transformers, each of 12 k.v.a., 600 volts primary, 100 volts secondary, are to be connected to 3-phase mains. State the primary and secondary full-load currents and voltages for the following methods of connection:—

(*a*) primary Y, secondary Y;

(*b*) primary Y, secondary delta;

(*c*) primary delta, secondary Y.

9. A condenser of 60 microfarads capacity is connected in series with 5 lamps, each of 4 ohms resistance, also in series, to a supply at 200 volts, 50 cycles per sec. Find the current, and the P. D. across each lamp.

How can lamps be switched off in this arrangement? If three of the lamps are switched off, find the new values of the current and of the P. D. across each of the remaining lamps.

B. Sc. Examination (Engineering), Part II, 1926.

(Common to Mechanical and Electrical Branches.)

Subject:—ECONOMICS OF ENGINEERING.

Paper-setter and Examiner—C. D. Thompson, M.A.

Time—Three Hours. Full Marks—50.

ANSWER SIX QUESTIONS ONLY.

ALL THE QUESTIONS ARE OF EQUAL VALUE.

1. Explain the chief methods of raising capital and floating a new business. What is meant by a prospectus? Is there any guarantee of the accuracy of statements made in a prospectus?

2. A certain Indian factory recently secured the services of thirty skilled machine operators from Europe at a salary of Rs. 400 per month. The work of putting the material into the machine and taking it out again required special skill. When the labourers arrived at the factory and saw the conditions of work, they demanded Rs. 800 per month. The company had already paid their passage to India. What facts would the manager need to consider before deciding whether to employ them or not? Is it possible that the men were justified in demanding so much?

3. If we take account of over-head charges, cost of materials, prices of finished product, and wages, how is a manager to decide on the quantity of output which will be most profitable with a given plant and equipment? Is it better to produce the same quantity every month or to vary the output? Explain the advantages and disadvantages of both methods.

4. Is it possible to measure in terms of money the efficiency of each labourer in a factory where the product passes through many machines and where some labourers do brain work such as designing and supervising, while others do purely manual work, such as carrying loads?

5. What are the best ways of paying wages in order to stimulate good work? Show that the system of wages payment must differ in different industries and in different departments of the same industry.

6. Tell what you can of profit sharing, co-partnership, sale of shares to labourers on easy terms, or other similar plans. What are the objects which the managers who introduce such methods hope to achieve?

7. Explain carefully how an estimate of the cost of a new job is arrived at. What determines the highest price that it would be safe to ask for a given piece of work? What is the lowest price that could be offered? Does a company ever offer to do work below its own estimate of the cost? Is this a sound policy?

8. Tell what you can about the calculation of depreciation, the depreciation fund, and calculations as to whether it will pay to scrap an old machine, and when it will pay to buy a new one.

9. The Agricultural Implements Co. at Jamshedpur has installed a plant for pulverising coal and supplying it by blow-pipes to all their small furnaces. The plant was very expensive, but has the advantage of saving labour, supplying a constant amount of coal to each furnace and thus keeping the heat constant in each furnace, and thirdly of extracting the maximum heat from a given quantity of coal. How can a manager decide whether such a plant will be profitable? Is it likely to be profitable in all industries where steel has to be tempered?

10. Describe the sales organisation of a large engineering works. What are the best methods for reaching the consumer directly and reducing the profits of middlemen? Can future production be planned on the basis of past sales?

B. Sc. Examination (Engineering), Part II, 1926.

(Mechanical Branch.)

Subject:—ECONOMICS OF ENGINEERING.

Paper-setter and Examiner—L. D. Coueslant, B.Sc. (Lond.), A.M.I.M.E., M.I.E.

Time—Three Hours. Full Marks—50.

ATTEMPT FIVE QUESTIONS ONLY.

1. Draw up a set of regulations for the store of a jobbing shop. Enumerate and describe the Storekeeper's books.

2. A square site is of two bighas area with one side running East and West abutting on a public road. Make a sketch plan of the buildings of an engineering shop, utilizing half the area to begin with but with a view to extension to cover the whole area.

3. Write down the principles on which you would proceed to the evaluation of the plant, buildings and site of an engineering workshop which has been several years in existence.

4. It is said that mass production methods tend to degrade the working classes. Beginning with a legal definition of the mass production factory write down the

heads of an Act of legislature intended to prevent this without hampering industry more than is necessary.

5. Write a short essay (about 1,000 words) on:—"Indian Cottage Industries and public Power Supply."

6. "At the present stage of India's Industrial progress, the country requires a larger expenditure on Motor Roads rather than on Railway Extension": Discuss this suggestion.

7. What are the main provisions of the Indian Factory Acts of 1911 and 1922?

B. Sc. Examination (Engineering), Part II, 1926.

(Electrical Branch.)

SESSIONAL PAPER.

The paper is given to Candidates immediately after the Durga Pooja Holidays. The completed designs must be given to the Principal of the Engineering College on or before March 1st, 1926. The designs should satisfy the following specifications:—

Group I.—STRUCTURAL DESIGN.

Paper-setter—L. D. Coueslant, Esq., B.Sc., A.M.I.M.E.
Examiner—J. Tullis, Esq., B.Sc., M.I.E.

Draw a horizontal line 20 units (representing feet) long, with lines sloping upwards at 45° to left and right at the ends. This is the rock profile of the cross section of the dry stream referred to under Group II.

The sessional work in Structures is the design and drawings of the masonry dam. Assume that the upward slope extends backwards indefinitely and design for a week's supply for the Pelton wheel. Penstock for Pelton wheel is to be included and a spilway to pass 1,000 cusecs of stormwater with a rise of not more than 12 inches. Lines of thrust on horizontal and vertical sections are required and a roadway 12 feet broad right across 6 ft. 6 ins. above water level.

Group II.—HYDRO-ELECTRICAL POWER DEVELOPMENT.

Paper-setter—L. D. Coueslant, Esq., B.Sc., A.M.I.M.E.
Examiner—J. W. Gaunt, Esq., A.M.I.M.E.

It is proposed to use 1,400 cusecs with a ten feet drop as follows to generate power—

Every day from 6 A.M. to 6 P.M.—2,000 H.P.

Every night from 6 P.M. to 6 A.M.—20 H.P.

Joining the river where the Power House is to be situated is a mountain stream usually dry rising 1,000 feet in 2 miles on the map. A dam is to be built across it at a point 2 miles distant from the Power House, and during the night the Francis turbines are to pump water up to the reservoir thus formed either by directly driven pumps or through electrical media.

During the day, power is to be obtained both from the Francis turbines and a Pelton wheel driven from the reservoir. None of the above machines are to be designed, but their speeds, powers, and water consumptions are required.

The sessional work in Hydro-Electrical Power Development is design and drawings of all pipe lines in connection with above scheme together with the necessary valves and the essential masonry work of the Power House. Any reasonable assumption within the specification may be made as to contour of main stream and the land surrounding the Power House.

Group III.—DESIGN OF ELECTRICAL MACHINES AND INSTALLATIONS.

Part A.

Examiners—S. Ghosh, Esq., M.I.E.E., M.I.E.; B. C. Chatterjee, Esq., B.A., B.L., B.Sc., M.I.E.E.

Make a preliminary design and estimate the cost of an Electrical Installation for supplying Light and Power to the City of Mirzapur. The plan may be consulted in the office of the Professor of Electrical Engineering.

Part B.

Examiner—R. S. Jain, Esq., B.Sc., A.M.A.I.E.E.

Design and prepare complete working drawings of an Induction Motor having a continuous capacity of 75 B.H.P. and speed 750 revolutions per minute:

The rotor being of the Wound type.

Voltage 2,200, 50-Cycle, 3-Phase.

The motor to be provided with an automatic switch to short circuit the rotor at full speed.

Maximum temperature rise after an 8-hour run at full load not to exceed 35°C.

Overload capacity 25 per cent. for two hours.

The maximum temperature rise not to exceed 50°C. even when the 2 hours' overload follows immediately on an 8 hours' run at full load.

The motor to give uniform torque from half to full speed without excessive heating.

Maximum torque to be 250 per cent. of full load torque.

The Maximum Efficiency and Power Factor at ½, ¾, Full and Overload to be as follows:—

Load.	½	¾	1	1½
Efficiency ...	85 %	87 %	89 %	88 %
Power Factor	78 %	85 %	88 %	89 %

Insulation test to be 6,600 A.C. Volts, 50-Cycle for one minute.

B. Sc. Examination (Engineering), Part II, 1926.

Subject:—STRENGTH OF MATERIALS AND ELECTRICAL TESTING.

Time—Three Hours. Full Marks—100.

Paper-setters and Examiners—L. D. Coueslant, B.Sc. (Lond.), A.M.I.M.E., M.I.E.; B. C. Chatterjee, B.A., B.L., B.Sc., M.I.E.E.

Use a SEPARATE answer book for each section, and indicate the section clearly on the cover of each answer book. Attempt either THREE questions from Section A and TWO from Section B, or TWO from Section A and THREE from Section B.

Section A.

1. On a polished piece of steel there is a mark which might be either an incipient crack or a slag inclusion. How would you test it in order to decide the question?

2. Describe the processes of hardening, annealing, and tempering steel. The Brinell hardness number of a piece of mild steel is 120. What to a near approximation is its ultimate breaking stress in tons per square inch?

3. How would you cast an iron roller required to have a very hard surface? How would you machine the surface?

4. Find diameters of wire and coil, and number of turns of a helical spring to extend 2 inches under a load of 50 lbs. with a stress of 30,000 lbs. per square inch.

SECTION B.

1. Give a specification for the oil to be used in high voltage transformers.

   Describe carefully how you will proceed to test the dielectric strength of the transformer oil supplied to you with the transformer.

2. Explain the principle underlying the grading of the insulation of high-voltage cables. What effect has standing of the conductors on the factor of safety of the insulation?

3. Give brief description of the preparation and properties of different kinds of varnishes used in the manufacture of electrical machines and apparatus.

4. The stator of a 15,000 K.V.A., 6,600 volt, three-phase alternator was burnt out. It was repaired in the power station by the manufacturer's men. State clearly what test will be performed before putting it to commission.

B.Sc. Examination (Engineering), Part II, 1926.

Subject:—THEORY OF STRUCTURES.

(Electrical Branch.)

Paper-setter and Examiner—Prof. T. E. Dodds, Wh.Sch., B.Sc. (Lond.), A.M.I.C.E., A.M.I.N.A.

Time—Three Hours. Full Marks—100.

NOT MORE THAN FIVE QUESTIONS TO BE ATTEMPTED.

1. A steel T section acts as a beam of clear span 10 feet and with rigidly fixed ends. The flange is 6 inches wide, the web 6¼ inches deep, and the thickness of the metal throughout ¾ inch. Determine the maximum safe uniformly distributed load which this beam can carry and the greatest shearing force then produced.

2. Derive an expression for the thrust exerted by earth (no surcharge) on the vertical back of a retaining wall.

   In the case of a wall of trapezoidal cross-section show how to calculate the moment of the capsizing couple, the moment of the righting couple, and the maximum and minimum intensities of stress on the base of the wall.

3. A steel stanchion 9 feet long, rigidly fixed at the base and free at the top, consists of an I section, 8 inches flanges, 6 inches deep, thickness of flanges 1 inch, and thickness of web ¾ inch. The point of application of an eccentric load is midway between the flanges and 3 inches at right-angles from the centre of the web. Calculate the safe eccentric load. Assume 'a'$=\frac{1}{9000}$ and 'f_c'$=6$ tons per square inch.

4. A masonry parabolic arch has a span of 60 feet, a width of 16 feet, a thickness of ring of 3 feet, and a rise of the centre line of the arch of 20 feet. Determine the maximum stress in the arch due to a uniformly distributed load of 3½ tons per foot run over the whole span.

5. Describe by means of figures and the employment of a planimeter how to determine the position of the centre of gravity of a rail section and the moment of inertia of the section about the neutral axis.

6. Design the central section of a built-up plate box girder for a clear span of 60 feet. The equivalent uniformly distributed dead load, inclusive of the weight of the girder, is 110 tons, depth of girder 1/20th of the span, and width of flanges 30 inches. Indicate on a sketch the curtailment of the flange plates.

7. A grillage foundation resting on clay supports the foot of a column. The load on the base plate is 270 tons and the maximum safe stress on the concrete is 16 tons per square foot and on the clay 2 tons per square foot. Calculate the size of the base plate, of the girders, and the overall dimensions of the foundation.

8. Show by means of a reciprocal figure how to determine the forces in the members of a French roof truss resisting a dead load and a wind load. There is a pin joint at one end of the truss and a roller bearing supporting the other end.

B.Sc. Examination (Engineering), Part II, 1926.

Subject:—HYDRAULICS.

(Electrical Branch.)

Paper-setter and Examiner—Prof. T. E. Dodds, Wh.Sch., B.Sc. (Lond.), A.M.I.C.E., A.M.I.N.A.

Time—Three Hours. Full Marks—100.

NOT MORE THAN FIVE QUESTIONS TO BE ATTEMPTED.

1. A circular hole 3 feet diameter in the vertical side of a tank is just covered by a plate. The centre of the plate is 6 feet below the water surface in the tank. Calculate the total pressure on the plate and the positoin of the centre of pressure.

2. A rectangular pontoon is 100 feet long, 40 feet wide and has a uniform draft of 20 feet. The centre of gravity of the pontoon is 5 feet above the bottom. Calculate the metacentric height of this pontoon.

   Describe an experimental method of determining the metacentric height of a vessel.

3. A Venturi meter with a throat $1\frac{1}{2}$ inches diameter is fitted in a $4\frac{1}{2}$ inches diameter pipe line. The pipe and throat are connected to a differential mercury gauge. The coefficient of the meter is 0.97. Plot a curve of discharge in gallons per minute against guage reading in inches of mercury from 1 inch to 10 inches.

4. Derive an expression for the rate of discharge over a sharp-edged V notch.

   The calibration test of a sharp-edged V notch gave $Q = 2.64\ H^{\frac{5}{2}}$ where Q is cubic feet of water per second and H is measured in feet. This notch is fixed to the side of a tank 20 feet long by 10 feet wide. Plot a curve of head against time, for H = 10 inches to H = 1 inch. There is no inflow to the tank.

5. A high level reservoir delivers into a single main 6 miles long, 3 feet diameter, laid at a slope of 9 feet per mile. The lower end of this main is connected by a Y-piece to two mains each feeding a separate low service reservoir. One branch main is 3 miles long, 2 feet diameter, with a fall of 10 feet per mile; the other is 5 miles long, 30 inches diameter, with a fall of 12 feet per mile. The water level in the high level reservoir is 30 feet above the centre of the pipe and that in each low level reservoir is 10 feet above the centre of its pipe. The water level in each reservoir remains constant. Take $f=0.007$. Calculate the delivery in gallons per hour to each low level service reservoir.

6. An open channel of square cross-section, laid at a slope of 1 in 1,500, is to convey half a million gallons of water per hour. The coefficient C in the formula $V=C\sqrt{mi}$ is :—

$$C=\frac{158}{1+\frac{0{\cdot}5}{\sqrt{m}}}$$

Determine the length of a side of the square cross-section.

7. A pelton wheel is required to work under an available head of 1,000 feet and to develop 800 h.p. at 400 r.p.m. Assume an efficiency of 84 per cent., a nozzle coefficient of velocity of 0.97, and a bucket speed of 0.46 of the jet velocity. Calculate the diameter of the jet, the diameter of the bucket circle, and the size and number of buckets. Sketch the cross-section of a bucket and the velocity triangle of the jet.

8. A reciprocating pump has a diameter of 9 inches, a stroke of 27 inches, and a suction lift of 10 feet. The suction pipe is 6 inches diameter and 80 feet long. Assume f for the pipe as 0.01 and the motion of the plunger as simple harmonic. Calculate the maximum speed of the pump without cavitation occurring between the piston and the water.

B.Sc. Examination (Engineering), Part II, 1926.

Subject:—THEORY OF MACHINES.

(Electrical Branch.)

Paper-setters and Examiners—L. D. Coueslant, B.Sc. (Lond.), A.M.I.M.E., M.I.E.; R. S. Jain, B.Sc., A.M.A.I.E.E.

Time—Three Hours. Full Marks—100.

Answer either THREE questions from Section A and TWO from Section B, or TWO from Section A and THREE from Section B.

Use a SEPARATE answer book for each Section, and indicate the Section clearly on the cover of each book.

SECTION A.

1. Design and sketch a pendulum with a total period of 2 seconds to be kept in continuous motion by an electro-magnet.

2. Get divided and total axial pitches, and pitch diameters of a pair of skew wheels to connect two shafts which are 8 inches apart at their nearest, and in planes at right-angles. The velocity ratio is to be 2; and the divided normal pitch 1 inch. The driving wheel which is to be the faster of the two is to have a pitch angle of 30 degrees.

3. Find diametral pitch for a wheel and pinion of cast iron to transmit 30 H.P. from a shaft running at 1,200 to one at 120 revolutions per minute. The permissible stress is 3,000 lbs. per square inch. The shafts are 22 inches apart.

4. Sketch a differential screw to give the strength of a $\frac{7}{8}$ inch Whitworth thread with an effective pitch of 1/72 of an inch.

Section B.

1. Explain fully what do you mean by wave form, how wave form of the e.m.f. changes and what wave form is desired in the design of an alternator. Also explain what you mean by harmonics, how do the harmonics come in a wave and how is a 3rd harmonic eliminated from an e.m.f. wave if a 3-phase alternator is star connected.

2. Develop the formulæ of the reactance voltage of a Transformer? What is the difference in the reactances of core and shell type transformers?

3. Explain fully the operation of a transformer at full load with the help of vector diagram.

4. Explain why and when a wound rotor induction motor is preferred to a squirrel cage induction motor, and why and when is the reverse the case. Also explain what are dead points and what are noises due to in an induction motor and what measures will you take in the design to remove both of the defects.

B. Sc. Examination (Engineering), Part II, 1926.

Subject:—HEAT ENGINES.

(Common for Mechanical and Electrical Branches.)

Paper-setter and Examiner—C. A. King, B.Sc., A.R.C.Sc., M.I.M.E., M.I.E.E., M.I.E.

Time—Three Hours. Full Marks—100.

ANSWER SIX QUESTIONS ONLY.
ALL QUESTIONS ARE OF EQUAL VALUE.

1. A gas engine has to develop 40 B.H.P. with an expected mechanical efficiency of 85 per cent., and a piston speed of 650 feet per minute.

   If the index n for the compression and expansion curves is taken as 1.32, and the maximum pressure of the explosion is 2.6 times the compression, determine the necessary diameter of the cylinder.

   Assume that the clearance volume is 27 per cent. of the volume swept by the piston, and that the diagram factor is 0.92.

2. Explain clearly why a high vacuum is essential for high efficiency in a steam plant. Sketch and briefly describe any one type of vacuum augmentor.

   The temperature of steam in a condenser is 52.3°C. and the pressure in the condenser is 2.25 lbs. per sq. inch absolute. Calculate the relative weights of steam and air in the condenser.

3. The volumetric percentage composition of gas supplied to a gas engine is CO 12.6, H_2 41.6, CH_4 26.6, CO_2 2.6, O_2 1.9, N_2 14.7 and the volumetric analysis of the dry exhaust gases is CO_2 8.53, O_2 4.9, N_2 86.57.

   Calculate the volume ratio of air to gas in the charge in the gas engine cylinder. Do you consider this charge to be a weak or a rich mixture?

4. Explain the advantages of a trip gear in cases requiring a very wide range of cut off. By means of carefully drawn sketches explain the action of the trip gear, and the mechanism by means of which the governor controls the point of cut-off.

5. Steam at a pressure of 225 lbs. per sq. inch and superheated 50°C is throttled down to 180 lbs. per sq. inch at admission to a triple expansion engine and exhausted into a condenser at 3 lbs. per sq. inch. If the steam consumption is 14.5 lbs. per I.H.P. hour, calculate the efficiency ratio between the admission and the exhaust pressures, taking the Rankine cycle as the standard for comparison. Sketch the temp. entropy diagrams for each stage assuming equal work done per stage.

6. Obtain the dimensions of a 3 stage air compressor to supply 12 lbs. of air per minute at 375 lbs. per square inch (absolute) with efficient cooling and intercooling. What power would be required to drive it?

7. Why are CO_2 and NH_3 the vapours that are most frequently used in refrigerating machines? Compare the advantages and disadvantages of these two vapours. Describe a machine using one of them.

8. Establish Clapeyron's Equation for the volume of a vapour; assuming Gibb's Function.

   Select any three successive values of temperature, pressure, and latent heat from your steam tables and calculate the specific volume of steam for the midmost pressure.

B.Sc. Examination (Engineering), Part II, 1926.

Subject:—ELECTRICAL ENGINEERING.

PAPER 1.

(Electrical Branch.)

Paper-setter and Examiner—W. T. Maccall, M.Sc., M.I.E.E.

Time—Three Hours. Full Marks—50.

Marks will be given for answers to not more than FIVE questions. Each one carries the same maximum marks.

1. A 7/.064″ cable 350 yards long, with vulcanized rubber insulation 49 mils. thick, has an insulation resistance of 880 megohms at 10°C.

   Find the insulation resistance (*a*) of 1,000 yards of this cable; (*b*) of 1,000 yards of 37/.064″ cable with insulation of the same quality, 75 mils. thick; (*c*) of both of these when the temperature rises to 32°C. (Given that 15°C. temperature rise halves the insulation resistance.)

   If the insulation were of impregnated paper would the change of resistance with temperature be more or less?

2. Describe the three-wire system and explain its advantages and disadvantages.

   Draw a diagram of connections for a rotating balancer, and for a static balancer, explaining how each of these acts.

3. How does the inductance of an overhead line vary with (*a*) the distance between the wires; (*b*) the size of the wires.

What influence has the latter variation on the choice of the material for the wires?

If the line voltage at the power station is 22,000 volts and the current 11.4 amperes, total line resistance 196 ohms, inductance 0.53-henry, frequency 50 cycles per second, find the line voltage at the delivery end.

4. What forms of apparatus are used for improving the power factor of an alternating current load, and what are their relative advantages?

What determines the best value to which to raise the power factor?

5. A transformer at full non-inductive load delivers 40 amperes at a terminal P. D. of 50 volts, and absorbs 2,130 watts from a 200-volt supply. Show how it can be connected as an auto-transformer to a 250-volt supply, and calculate its output and efficiency at full non-inductive load when so connected, neglecting the effects of the magnetizing current.

If the no load current of the auto-transformer is 0.52 ampere with a power factor of 0.4 draw a vector diagram, including this, for 1/10th full load, and find the currents in the two windings at this load.

6. Three transformers are to be connected to a three-phase supply with 3,000 volts between lines to convert a total load of 120 kilovolt-amperes to a line pressure of 380 volts. If each secondary turn produces 3.7 volts, find the numbers of turns and the currents in the primary and the secondary windings if these are to be connected:—

(*a*) both *Y*;

(*b*) primaries *Y*, secondaries delta;

(*c*) primaries delta, secondaries *Y*;

(*d*) both delta.

Which of these arrangements can be connected in parallel with one another?

7. A six-pole three-phase induction motor for a line P. D. of 400 volts, 50 cycles per second, takes at no load and full pressure, 12 amperes per line, and a total of 1,150 watts; and takes at standstill and 80 volts, 43 amperes per line, and a total of 1,650 watts.

Draw its circle diagram and find:—

(*a*) The maximum power factor, and the corresponding values of the line current and the brake H.P.;

(*b*) the maximum torque in pound-feet which the motor can exert.

Take the stator copper loss as 45 per cent. of the total copper loss.

8. In a three-phase rotary converter delivering 200 amperes C.C. and working at unity power factor find, neglecting losses:—

(*a*) the R. M. S. value of the line current;

(*b*) the R. M. S. value of the alternating current in the windings of the rotary.

Sketch a graph showing the wave form of the current in an armature conductor 25° (electrical) from a tapping point. Find the R. M. S. value of this current. Hence estimate the maximum output of the rotary compared with that of the same machine used as a C.C. generator.

9. Describe the method of action of a compensated series monophase motor suitable for traction.

Note the points in which it differs from a C.C. series motor, giving reasons for these differences.

How can the speed of this monophase motor be altered?

B.Sc. Examination (Engineering), Part II, 1926.

Subject:—ELECTRICAL ENGINEERING.

PAPER II.

(Electrical Branch.)

Paper-setter and Examiner—Prof. B. C. Chatterjee.

Time—Three Hours. Full Marks—100.

Marks will be given for answers to not more than FIVE questions. The maximum for each is 20.

1. What is meant by resonance in an electrical circuit? A condenser of 1.5 microfarad capacity and a variable choking coil of 15 ohms resistance are connected in series to a 50-cycle, 100-volt supply, the wave shape of which has a strong third harmonic. What value of the inductance will give resonance (*a*) with the third harmonic, (*b*) with the fundamental frequency?

2. Describe the tests you will perform and precautions you will take before you run a 7 K.V.A., 220/13,200 volt transformer standing idle for over a year since its delivery to the station. The transformer was received assembled in the tank, but the oil was in a separate container.

3. What size generator, in kv-a. (Kilovolt-amperes), is required to supply a system comprising induction motors taking 100 kilowatts at 80 per cent. power-factor, incandescent lamps taking 50 kilowatts at 100 per cent. power-factor, and idle transformers taking 10 kv-a. at 40 per cent. power-factor. Assume these values to include the power used to overcome losses and reactions in the corresponding distributing wires.

4. A consumer receives 500 kw. three-phase power under a line voltage of 2,000 at 50 frequency. The power-factor is 0.70. It is desired to bring this up to 0.85, by means of (*a*) condensers in mesh connection, (*b*) a synchronous motor.

Determine the capacity of the former and rating of the latter. Which of the two do you prefer and why?

5. Describe carefully the method of measuring power by two watt-meters in an unbalanced three-phase system.

6. What are the reasons for and against earthing the neutral in three-phase high-tension systems of distributing power? Describe with a diagram of connections the method you would consider best for a 6,600-volt three-phase system. Explain its working and give reasons for preferring the method described.

7. Two 1,000-kv-a. alternators each running as a single-phase machine and each having a voltage of 6,600 volts were thrown in parallel, when they were at what was believed to be the correct phase relation, that is, the e.m.f.'s were supposed to be 180° apart. Generator A, however, was 20° ahead of this correct 180° position with regard to generator B. Each generator has a 10 per cent. inherent reactance and a 2 per cent. resistance. Which generator delivers synchronizing power to the other, and how great is this power?

8. A monophase distribution line of 5/0 S. W. G. (res.—.00017 ohms/yd.) is fed at 550 volts from both ends. The line is 2,800 yds. long. Beginning from one end at distances of 400, 1,000, 1,400, 2,000 yds. respectively, there are distribution centres tapping current 50 amps. in each junction. Find the voltages at each of the four junction points and the current fed from each end.

9. Explain the action of a monophase mercury arc rectifier. What A. C. voltage will it have for charging a Secondary Battery of 110 cells? Will a moving coil permanent magnet D. C. voltmeter correctly read the voltage on the battery side of the apparatus?

B.Sc. Examination (Engineering), Part II, 1926.

Subject:—ECONOMICS OF ENGINEERING.

Examiner—Prof. B. C. Chatterjee, B.A., B.L., B.Sc., M.I.E.E.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY OF WHICH QUESTIONS 1 AND 3 MUST BE ATTEMPTED.

1. What minimum cost of coal will make the Hydro-electric project at the Chandraprova river, 36 miles from Benares, economically feasible to supply power to Benares and Railway Workshops at Moghulsarai? The total demand of the two places may be met by the scheme which is capable of 2,700 kw. continuous production. The combined annual load-factor is 40 per cent. Make your assumptions for calculations.
2. Make a summarised statement of the Report you will submit when you are called upon to make an investigation into the economical probability of the above hydro-electric project.
3. Give a brief summary of the precautions to be adopted for the Protection and Maintenance of Aerial Lines as required by the Indian Electricity Rules of 1922.
4. What do you mean by Revenue Account of a Power Supply Company? What is the usually recommended form in which it is kept by a company (with a fuel-fired station) supplying a big city like Calcutta?
5. The 'A' power supply company's power station is being bought by a 'B' company. State clearly how you will carry out the valuation of the aforesaid station necessary before the transfer.
6. What is the relation between profit and cost? Describe the different elements of cost that enter a big fan-making concern. In how many ways can you increase the profit of a concern?
7. Draw out a specification for the purchase of a steam-plant for electric power generation.

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First Year Diploma Annual Examination, 1926.

Subject:—MATHEMATICS.

Time—Three Hours. Full Marks—100.

1. (*a*) Find the value of

$$2{\cdot}625^{2{\cdot}5} \times 0{\cdot}0625 \times 16{\cdot}06^{-0{\cdot}083}$$

(*b*) How many ciphers are there between the decimal point and the first significant figure in $(0{\cdot}0504)^{10}$?

(*c*) Find to four significant figures the value of

$$\text{Sin } 116^0 \tan^2 218^0 \div \sqrt{(\cos 102^0)}$$

2. Solve the following equations: –

(*a*) $(\frac{1}{2})^{(x+)4} = (25)^{(3n+2)}$

(*b*) $x = \frac{16}{15} + \frac{1}{x}$

(*c*) $zx = y^2$

$x+y+z=21$

$x^2+y^2+z^2=189$

3. (*a*) Prove that

$$\frac{\text{Sin } 3A - \text{Sin } A}{\cos 3A + \cos A} = \tan A$$

(*b*) Given the two sides of a triangle b and c equal to 3·45 and 11·74 ft. respectively, and angle $A=37°20'$; find the angles B and C the remaining side a, and area of the triangle.

4. (*a*) Solve the equation

$$\text{Cosec } \theta + \cot \theta = \sqrt{3}$$

(*b*) The angle of elevation of a steeple at a place due south of it is 45°, and at another place due west of the former the angle is 16°. If the distance between the two places is 100 ft., find the height of the steeple.

5. (*a*) A ball of iron 4 inches diameter is covered with lead Find the thickness of the lead so that (*i*) the volumes of the iron and lead are equal, (*ii*) the surface of the lead is twice that of iron.

(*b*) The water in a rectangular reservoir is $9\frac{1}{2}$ ft. deep and covers an area of 5390 square yards. In what time can the water be emptied by a pipe 5 inches in diameter, through which the water runs at the rate of 17 miles an hour?

First Year Diploma Annual Examination, 1926.

Subject:—APPLIED MECHANICS.

ANSWER FIVE QUESTIONS ONLY.

THE QUESTIONS ARE OF EQUAL VALUE.

Time allowed 3 hours.

1. Of what use is a "Toggle Joint"? Sketch the arrangement and show graphically, using Bow's Notation, how we may use it in order to exert great pressure.

2. Sketch and describe the Lever Safety Valve.

If the area of the valve is 3 square inches and the blow off pressure is to be 100 lbs. per sq. inch by gauge, sketch the arrangement giving weights and dimensions.

3. What is meant by the " Principle of Work " as applied to a machine. Define the following terms: Mechanical advantage, Velocity ratio and Efficiency as applied to a simple machine. Illustrate your answer by special reference to the Screw Jack. Give sketches.

4. State the " Laws of Solid Friction " and how you would proceed to illustrate and prove their accuracy or otherwise.

An inclined plane is slowly tipped up until a body resting upon it just slips down at a uniform rate if given a start If the angle at which this occurs is 30°, what is the coefficient of friction between the body and the plane?

5. It is found that the relation between the Load and the Effort for a simple machine follows the Straight Line Law. When the load is 10 lbs. the effort is 2.5 lbs., and when the load is 30 lbs., the effort is 6 lbs. Find the effort when the load is zero and when the load is 50 lbs. Write down the equation to the straight line.

6. A pump is driven by an electric motor taking 30 Amperes at 220 Volts. If the efficiency of the motor is 80 per cent. and of the pump 70 per cent., how many gallons of water will the pump deliver per minute to a height of 60 feet?

7. Compare the advantages and disadvantages of a belt drive with those of a gear.

Give an instance in which the drive must be by means of gear wheels and one in which a belt drive is preferable.

Find a train of gear wheels which will give a veocity ratio of 1:10.

First Year Diploma Annual Examination, 1926.

Subject:—HEAT ENGINES.

ANSWER FIVE QUESTIONS ONLY.

THE QUESTIONS ARE OF EQUAL VALUE.

Time allowed 3 hours.

1. Explain clearly what is meant by the followning expressions:—Dry Steam, Dry Saturated Steam, Wet Steam, Superheated Steam, Dryness Fraction and Wetness.

   What is a "Superheater," where is it placed and why is it used? How does a Superheater tend to prevent the initial condensation which takes place when Saturated Steam is used?

2. Sketch and describe in detail a vertical "cross-tube" boiler. Why is this type of boiler inefficient? In what respects is the Cochran boiler superior to the ordinary cross-tube vertical boiler?

3. Sketch and describe the following boiler fittings:—Feed check valve, Gauge glass, Stop Valve, Anti-priming pipe and Safety valve.

   How is a man-hole door fitted and rendered steam-tight?

4. Prove the construction known as the Reuleaux valve diagram.

   The connecting rod of a steam engine is equal to four cranks in length and the cut-off takes place at .7 of the stroke. Find the position of the crank at cut-off and draw the valve diagram given that the travel of the valve is 3 inches and the lead $\frac{1}{4}$ inch and the release at .9 of the stroke.

5. Explain clearly how you would proceed to start a steam engine of moderate power. Mention clearly all the precautions necessary and why.

Why is a governor necessary for some engines and not for others? What are the conditions that must be fulfilled by a steam engine governor?

6. What is a Separator and what is a Steam Trap? Why are both necessary and where are they placed?

Find the thickness of a steel pipe 12 inches in diameter that is necessary in order that the stress in the material may not rise above 4 tons per square inch. The internal pressure being 200 lbs. per square inch by gauge.

7. Sketch the piston of a small gas or oil engine and compare it with the piston of a steam engine. They are of quite a different shape, why is this? Why is no stuffing-box necessary for the oil or gas engine? How is the piston lubricated?

8. Sketch a pair of driving wheels for a locomotive and show clearly how the coupling rod is attached to them and how they are shaped so as to assist in the balancing of the engine. If you have not noticed these things, your eyes are not sufficiently open yet.

First Year Diploma Annual Examination, 1926.

Subject:—MECHANICAL DRAWING.

Time—Four hours. Full Marks—100.

N.B.—QUESTION 1 MUST BE ATTEMPTED.

FIVE QUESTIONS ONLY TO BE ANSWERED.

1. The accompanying drawing represents a steel cross-head, suitable for a vertical steam engine. Draw the two views as they are shown in the drawing and also add an end view half in section, looking in the direction of the arrow. *Scale Half Full Size* 60

2. Show by sketches the forms of triangular, square and buttress threads, mark their standard proportions on your sketches 10

3. Make neat sketches of a cottered joint such as is in frequent use for pump rods 10

4. Sketch two views of a knuckle joint suitable for connecting rods of one inch diameters, mark the standard proportions of the joint 10

5. Distinguish between a key and a cotter. Sketch an example of each, stating the purpose for which each is employed 10

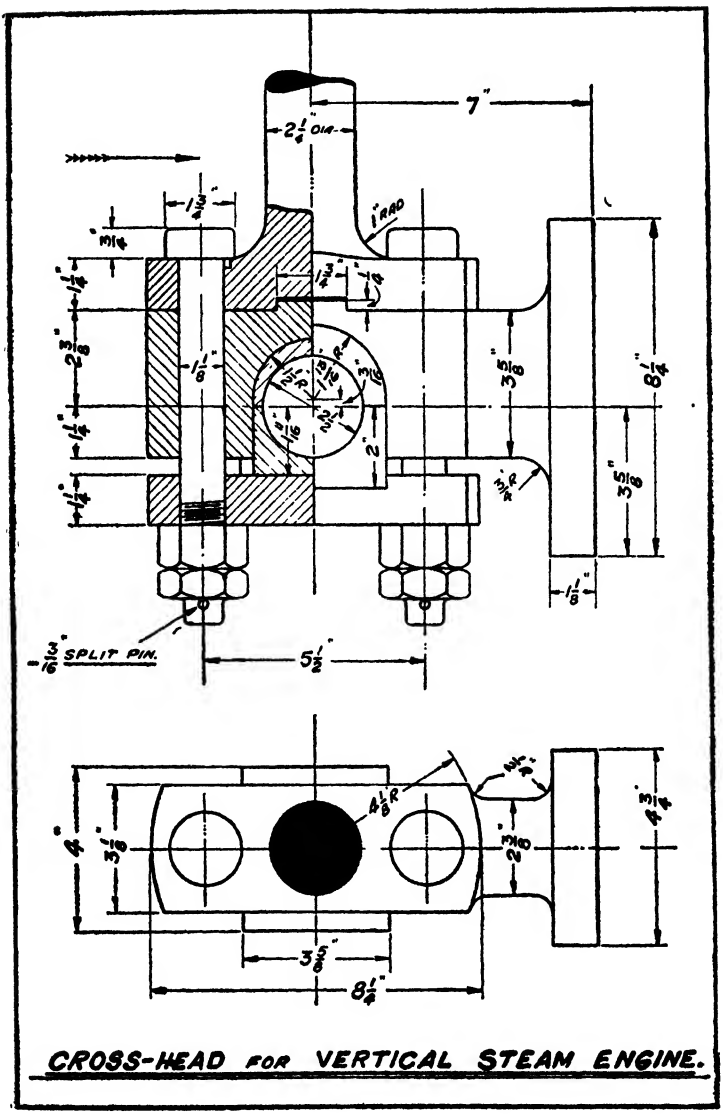
6. Show by sketches how the separate lengths of a line of shafting may be connected together ... 10

7. Give sketches showing one method of attaching the valve rod to an ordinary slide valve ... 10

8. Define "outside lap," "inside lap," "lead," and "travel" of a slide valve. Make sketches illustrating your answer 10

9. Make neat sketches showing two forms of steam engine pistons 10

10. What is meant by the "draw" of a cotter? Make a sketch showing how a crosshead is secured to a piston rod by a cotter 10



CROSS-HEAD FOR VERTICAL STEAM ENGINE.

Question I.

First Year Diploma Annual Examination, 1926.

Subject:—BUILDING.

Time—Three hours. Full Marks—100.

[N.B.—*The figures in the margin indicate full marks.*]

1. Give a brief description of a log of timber from the time it is felled to the time it is used as beams in a building 20

2. What is concrete? What precautions are necessary in its preparation and use in foundations of buildings 20

or

Classify ordinary bricks, and state the characteristics of the best variety.

3. Explain clearly what you understand by the following:—

   (*a*) Shakes in timber.

   (*b*) Natural bed of stones.

   (*c*) Setting of lime.

   (*d*) Artificial stones 20

or

Give neat sketches of the following:

   (*a*) Brick-on-edge flooring, herring-bone pattern;

   (*b*) Squared rubble masonry built in courses;

   (*c*) A segmental arch on pier and abutment, naming all parts.

4. Draw to a scale of 2 feet to an inch two consecutive courses of bricks laid in English Bond at the junction of a 1-brick wall with a 2-brick wall 25

or

Explain clearly with sketches the meaning of the following terms:—

(*a*) Quoins,
(*b*) Copings,
(*c*) Dowels,
(*d*) Benching out, and
(*e*) Relieving arch.

5. What are the main points to consider in designing foundations of buildings 15

or

What do you understand by the expression, "proper orientation of a dwelling house"?

First Year Diploma Annual Examination, 1926.

Subject:—SURVEYING.

Time—Three hours. Full Marks—100.

[*The questions carry equal marks.*]

1. Construct a diagonal scale of 64 inches=1 mile to read Gunter's chains and links. Indicate a distance of 4 chains and 67 links on your scale.

2. Give neat and explanatory sketches of the following:—

(*a*) An exact length of two feet from one end of a 100 feet chain;

(*b*) Graduations of a Prismatic Compass to compare with those of a Surveying Compass.

or

Explain with the help of neat sketches the various methods of taking offsets from a chain line.

3. The plan of an old survey plotted to a scale of 41.66 feet = 1 inch was found to have shrunk so that a line originally 10 inches long was only 9.86 inches. There was also a note stating that the chain used was 0.2 link too long.

If the area of the plan given by a planimeter was 34.76 square inches, what was approximately the correct area of the survey?

or

Plot the following to a scale of 100 feet = 1 inch, and find out the length and bearing of the closing line:—

Line.	Magnetic Bearing	Length.
AB ...	... 30° ...	... 200 ft.
BC ...	... 300° ...	... 300 ,,
CD ...	... 240° ...	... 350 ,,

State also the back bearings of all the lines.

4. Explain clearly what you understand by the following:—

(*a*) Tie-line,

(*b*) Traverse survey,

(*c*) Bench mark,

(*d*) Parallax, and

(*e*) Variation of a compass.

or

Explain with neat sketches the permanent adjustments of a Dumpy Level.

5. Write out an imaginary page of a level book, recording 3 sets with 2 intermediate readings in each set, bearings of the station lines, and a milestone as B. M. taken from the first set of the instrument 30 feet to right at 200 feet, showing also a corresponding plan of the ground.

Assuming the R. L. of the B. M. to be 100.00, calculate the Reduced Levels of all other points by the Rise and Fall method, showing arithmetical checks.

First Year Diploma Annual Examination, 1926.

Subject :—PHYSICS.

Time—Three hours. Full Marks—100.

Answer FIVE questions only.

1. A scale is divided into 20ths of an inch and has to be read to 1/25th of a scale division by means of a vernier. Show by sketches how to construct a suitable vernier.

2. Define the units of heat.

A boiler is made of mild steel and weighs 10 tons. The specific heat of the material is .12. The boiler contains 8 tons of water. Find the quantity of heat required to raise the temperature of the whole from 15°C to 100°C, assuming no waste.

3. Describe and give sketches of any apparatus you have used for finding the coefficient of linear expansion of a metal. Show how the results would be calculated.

or

The density of a piece of brass is 8.456 gms. per c.c. at 15°C and the coefficient of cubical expansion is 57×10^{-6}. Find the density of the brass at 125°C.

4. Define thermal conductivity and explain how its value may be determined in the case of copper. Give a neat sketch of the apparatus to be used

or

Calculate the quantity of heat which will flow per hour through an iron plate 1.25 c.m. thick. State the result in calories per square meter of the plate. The coefficient of conductivity is .14 and one face of the plate is at a temperature of 10°C higher than that of the opposite face.

5. Enunciate the laws of Boyle and Charles.

A cylinder fitted with a piston contains at a certain instant 6 cu. ft. of gas at 15 lbs. per square inch absolute and 15°C. Operations are being conducted on the gas involving changes in pressure, volume and temperature, the weight of gas present being kept constant. At another instant, the pressure is found to be 150 lbs. per square inch absolute and the volume 2.5 cubic feet. Calculate the temperature at this instant.

6. One pound of coal has a heating value of 8,000 lb.-degree-centigrade. By means of suitable machinery 500 gallons of water can be raised to a height of 100 feet for each pound of coal burned. What percentage of the heat contained in the coal is converted into useful work?

Take J = 1,400 ft. lbs. per lb.-degree-centigrade.

First Year Diploma Annual Examination, 1926.

Subject:—CHEMISTRY.

Time—Three Hours. Full Marks—100.

1. What do you mean by a law of nature? State, giving examples, the following laws:—

   (*a*) Law of multiple proportion.

   (*b*) Boyle's Law.

   (*c*) Charles' Law.

2. What do you mean by the following terms:—

   Valency of an element, equivalent weight, gram molecule, endothermic and oxidation.

   What are the valencies of the different elements in the following compounds:—

   NH_3, CO_2, H_2O, Al_2O_3 and CS_2

3. Why is hard water unsuitable for washing as well as for boiler?

   What do you mean by degree of hardness?

   Calculate the amount of Na_2CO_3 required to remove permanent hardness from a thousand gallons of water having ten degrees of hardness, on the English system.

4. What do you understand by a chemical formula and a chemical equation? Express by means of chemical equations the chemical change taking place when:—

   (*a*) Limestone is heated in a kiln.

   (*b*) Carbon dioxide is bubbled through lime water.

   (*c*) Potassium chlorate is heated.

5. What mass of zinc will be consumed to fill a balloon of 1,000 litres capacity with hydrogen at 800 mm. pressure and 30°C; density of hydrogen at normal temperature and pressure being 0.0893 gram per litre, and atomic weight of zinc 65.4.

6. Give a full-page diagram giving a brief but clear outline of the various operations in an iron and steel works undertaking the manufacture of pig iron from its ores and also indicating the various ways in which the products of the blast furnace may be used.

7. What is a blast furnace? Give a brief account of the various chemical and physical changes which take place in such a furnace used for the smelting of iron ore.

8. Briefly describe the properties of lead, mentioning the various industrial and commercial uses of the metal as such or as an alloy.

First Year Diploma Annual Examination, 1926.

Subject:—ELECTRICAL ENGINEERING.

[*Try two questions from Group A and three from Group B.*]

Time—Three Hours. Full Marks—100.

GROUP A.

1. Define Magnetic Field, Intensity of Field, Lines of Force, Magnetic Moment and Unit Pole. What is the couple acting on a magnet 12 c.m. long and of pole strength 7 units placed at an angle of 60° with the direction of a field of strength .017 unit.

2. Describe the difference between the magnetic properties of soft iron and hard steel. Which would you use (*i*) for the core of an electro-magnet, (*ii*) for a permanent magnet? Give reasons for your answer. What effect has a change of temperature on a magnetised steel bar?

3. Two short bar magnets, the moments of which are 108 and 192 respectively, are placed along two lines drawn on the table at right angles to each other. Find the intensity of the magnetic field due to the two magnets at the point of intersection of the lines, the centres of the magnets being respectively 30 c.m. and 40 c.m. from this point.

GROUP B.

4. Define the practical units of current strength quantity, potential difference and resistance. Define also Erg, Joule, Watt, Kilowatt and Board of Trade Unit of Electrical Energy.

5. The resistance of one mile of No. 10 B. W. G. pure copper wire is 3.12 ohms, and the diameter of this wire is .134 inch. Calculate the resistance of a quarter mile of German silver wire .065 inch in diameter having given that the specific resistance of German silver is 13 times that of copper.

6. A dynamo producing a terminal potential difference of 150 volts is used to charge 60 storage cells, each having an E. M. F. of 2.2 volts and a resistance of .001 ohm. If the leads joining the dynamo and cells have a resistance of .2 ohm, what will be the charging current?

7. A Generator feeds 81, 16-c.p. lamps for four hours; calculate the cost of the energy supplied at 4½d. per unit if each lamp absorbs 1.1 watt per c.p.

Preliminary Examination, Egineering Diplomas, 1926.

Subject:—MATHEMATICS.

PAPER I.

Paper-setter and Examiner—S. N. Maitra, I.E.S., M.A., A.R.C.Sc.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

THE QUESTIONS ARE OF EQUAL VALUE.

1. There are two formulæ used to calculate ϕ :—$\phi = \log_e \frac{t}{273}$ which is only approximate; and $\phi = 1{\cdot}0565 \log_e \frac{t}{273} + 9 \times 10^{-7}\left(\frac{t^3}{2} - 503t\right) + 0{\cdot}0902$. Which is correct? If $t = \theta + 273$ when $\theta = 53$, find the two answers; what is the percentage error in using the approximate formula?

2. (*a*) If α and β be the roots of $x^2 + px + q = 0$, find the equation whose roots are $\frac{\alpha}{\beta}$ and $\frac{\beta}{\alpha}$.

   (*b*) In how many ways can the letters of the word *Utilitarianism* be rearranged without changing the position of any of the vowels?

3. (*a*) Write down the coefficient of x^{2r+1} in the expansion of $\left(x - \frac{1}{x}\right)^{2x+1}$

   (*b*) Evaluate $\sqrt{24}$ by means of the Binomial theorem, to five places of decimals.

4. (*a*) Express Sin $2\pi nt$ Sin $(2\pi nt+g)$ as a sum or difference and verify numerically for the case $n=10$, $t=0{\cdot}01$, $g=0{\cdot}3491$ radian.

(*b*) Two sides of a triangle are measured and found to be 32·5 and 24·2 inches; the included angle being 57°, find the area of the triangle. If the true lengths of the sides are really 32·6 and 24.1, what is the percentage error in the answer?

5. *Either*

Represent graphically the curve $\gamma=e^{0{\cdot}35\theta}$ where γ and θ are the polar co-ordinates of a point.

or find approximately $\int_{1\cdot5}^{3} r^{r}\,dr$.

6. (*a*) Find the differential coefficient of $\tan^{-1}\frac{x}{a}$

(*b*) Magnus' empirical formula for the pressure and temperature of a gas is $p=ab\frac{\theta}{\gamma-\theta}$, where a, b and γ are constants. Find $\frac{dp}{d\theta}$.

(*c*) Inscribe in a given sphere a cone whose volume is a maximum.

7. By the methods of the integral calculus find—

(*a*) the volume of a sphere;

(*b*) the moment of inertia of a solid cylinder about an axis passing at right-angles through the middle point of the geometrical axis of the cylinder.

Preliminary Examination, Egineering Diplomas, 1926.

Subject:—MATHEMATICS.

PAPER II.

Paper-setter and Examiner—Sohan Lal, M.Sc.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

THE QUESTIONS ARE OF EQUAL VALUE.

1. (*a*) If $\theta = 0{\cdot}8\,\pi$, $\mu = 0{\cdot}3$ and $N = M\,e^{\mu\theta}$; if $(N - M)\,V = 33{,}000\,P$; if $P = 30$ and $V = 520$; find N.

   (*b*) Find the value of $10e^{-0{\cdot}7t}\mathrm{Sin}\,(2\pi\,ft + 0{\cdot}6)$, where f is 225 and t is 0·003. Observe that the angle is stated in radians.

   (*c*) If $A = P\,(1 + \frac{r}{100})^n$, and if $A = 3P$ when $r = 3\frac{1}{2}$, find n.

2. (*a*) Write out a formula for the volume V of a hollow circular cylinder of length l, inside radius r, outside radius R.

   If $V = 182$ cubic inches, $l = 7{\cdot}23$ inches, $r = 2{\cdot}11$ inches, find R.

   (*b*) The inside diamater of a hollow sphere of cast-iron is the fraction 0·57 of its outside diameter. Find these diameters if the weight is 60 lbs. Take 1 cubic inch of cast-iron as weighing 0·26 lb.

3. (*a*) Prove that :—Sin (A+B) = Sin A CosB+CosA Sin B.

You may take the simplest case, when A+B is less than a right-angle. Illustrate the truth of this arithmetically when A=35° and B=27°.

(*b*) Prove that in a triangle whose sides a, b contain between them the angle C, the area is $\frac{1}{2}\,ab$ Sin C.

There is a quadrilateral ABCD, A and C being opposite corners. If AB is 16·23 feet, AC 25·4 feet, AD 12·09 feet ; if the angle BAC is 41°, and the angle CAD is 35°, find the area of the quadrilateral.

4. (*a*) It is required to find the height of a house on the opposite bank of a river. The elevation of the top of the house is read at a certain point as 17° ; at a point 86 feet nearer to the house, the elevation is found to be 31°. Find the height of the house.

(*b*) Solve the triangle ABC completely. being given that B=35° 30′, B=38·6, C=43·57.

5. (*a*) In a geometrical progression where r is the ratio of any term to the previous one, prove the rules for finding the nth term and the sum of n terms.

The sum of a geometrical series of 16 terms is 1,020, $r=2{\cdot}4$, find the first and last terms.

(*b*) Plot the curve :—

$y=a$ Sin $(cx+d)$ for the case when $a=2$, $c=2$ and $d=\frac{\pi}{3}$.

6. (*a*) Differentiate :—

$$\frac{a+\sqrt{x}}{a-\sqrt{x}}; \qquad \sqrt{\frac{a-x}{a+x}}$$

$$x\sqrt{(a-x)\,x}; \qquad \sqrt{1+3\tan^2\theta}$$

(*b*) In the curve to which the equation is $4x^2+9y^2=36$ find the values of x at those points where the slope is 1.

7. The motion of a rising balloon is such that its height h, in miles, is given at any instant, by the expression :—

$$h = 0{\cdot}5 + \tfrac{1}{10}\sqrt[3]{t} - 125 \text{ ; } t \text{ being in seconds.}$$

Find the expression for the velocity and the acceleration at any time. Draw curves to show the variation of height, velocity and acceleration during the first ten minutes of the ascent.

8. (*a*) A spherical balloon is increasing in volume. If when its radius is r feet, its volume is increasing at the rate of 4 cubic feet per second ; at what rate is its surface then increasing ?

(*b*) Inscribe in a given cone, the height of which is equal to the radius of the base, a cylinder whose volume is a maximum.

9. (*a*) Integrate :—

(i) $\sqrt{3+8x}$; (ii) $x \log_e x$

(iii) $\dfrac{1}{9-x^2}$; (iv) $\text{Sin}^2 x$

(*b*) Find the area, between limits $x=a$ and $x=0$, of the curve $y=\dfrac{b}{x+a}$.

10. Find the surface and the volume generated by a Cosine curve as it revolves about the axis of x between $x=0$ and $x=\dfrac{\pi}{2}$.

Preliminary Examination, Engineering Diplomas, 1926.

Subject:—APPLIED MECHANICS.

Paper-setter and Examiner—L. D. Couesiant, B.Sc. (Lond.), A.M.I.M.E., M.I.E.

Time—Three hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

1. If your weight is 120 lbs., and the coefficient of friction of your feet on the ground is 0.4, express numerically your value as a member of a tug-of-war team.

2. Water is flowing at 5 feet per second round a right-angle bend in a pipe 24 inches in diameter, completely filling the pipe. Find the magnitude and direction of the impulsive force on the pipe.

3. Three inches from the end of the stroke of an engine of total stroke equal to 12 inches, the acceleration of the piston is 10 feet per second. Assuming simple harmonic motion, find the speed of the engine in revolutions per minute.

4. Two pulleys of equal diameter 80 feet apart, and at same level are connected by a single rope belt. The weight of this rope is 0.25 lb. per foot, and its linear speed 2,500 feet per minute. If the sags on the tight and slack sides are respectively 3 inches and 18 inches, what Horse Power is being transmitted?

5. A wooden beam has cross section 6 inches broad and 12 inches deep. Two inches below the neutral axis the stress intensity is 15 lbs. per square inch. What is the bending moment, and what the maximum stress in the beam at that section?

6. Sketch and describe a method by which water flowing along a downward inclined pipe may be used either as an air pump or as an air compressor, or as both.

7. A hollow steel shaft is 10 inches in external diameter with a bore d inches in diameter. Assume d equal to 3, 6, and 8 inches and for these values tabulate the strength and weight of 20 feet of the shaft.

8. Assuming Bernoulli's law, obtain a formula connecting the quantity of water flowing through a Venturi meter with the difference of preessure.

9. In parallel colums compare the laws of solid and fluid friction. In the case of each of these laws, say, to what extent they may be regarded as exact or approximate.

Preliminary Examination, Engineering Diplomas, 1926.

Subject:—HEAT ENGINES.

Paper-setter and Examiner—C. A. King, B.Sc., A.R.C.Sc., M.I.M.E., M.I.S.E., M.I.E.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

1. Find the thickness of the shell plate for a boiler 8 feet 4 inches in diameter and 150 lbs. per square inch working pressure, by gauge. Allow for the efficiency of the riveted joints.

   Design a suitable circumferential ring joint and a longitudinal butt joint for this shell and compare the efficiencies you obtain with the efficiency that you assumed when calculating the thickness of the plate. Use rivets $\frac{7}{8}$ inch diameter.

2. Explain clearly what is meant by the angle of advance of an eccentric and why it is necessary.

   The connecting rod of an engine is equal in length to four cranks and the cut-off takes place at $\frac{5}{8}$ths of the

stroke both forward and backward. The travel of the valve is 3 inches and the lead for the forward stroke is $\frac{1}{4}$th inch. Find the outside lap for the forward and for the return stroke, also the lead for the return stroke.

Now choose what you think to be suitable values for the inside laps and sketch the two indicator diagrams by projection from the valve diagrams you have drawn. Compare the two indicator diagrams and point out any possible improvements. Choose any pressure you like.

3. Describe Stephenson's link motion and explain the method of finding the equivalent eccentric for any position of the block in the link.

4. You are required to purchase a boiler for some mill, factory or electric light station. State clearly what factors would affect your choice and why.

   (*A long wordy answer to this question will receive no marks; if you leave out any important consideration you will get no marks.*)

5. Sketch and describe some form of vertical boiler and enumerate the fittings and equipment that should be supplied with the boiler.

6. What is meant by the "Willan's Line" and to what type of steam engine does it apply? The following results were obtained from a test of a steam engine controlled by a throttling governor:—

I. H. P.	Pounds of steam per hour.
208	3,210
920	12,000

What would be the probable consumption per I.H.P.-hour at 600 I.H.P.?

Preliminary Examination, Engineering Diplomas, 1926.

Subject:—BUILDINGS AND CIVIL ENGINEERING DRAWING.

Paper-setter and Examiner—H. K. Sen, M.I.M.E.

Time—Four Hours. Full Marks—100.

1. Where are the following stones found in India, and for what purposes are they used:—

Trap, Sandstone, Slate, Limestone, and Kankar?

or

What is mortar? What are its uses? What precautions are necessary in using it? What are the qualities to be sought for in good mortar?

2. (*a*) What are the main points to consider in designing foundations of buildings?

(*b*) Discuss the various causes of failure in structures.

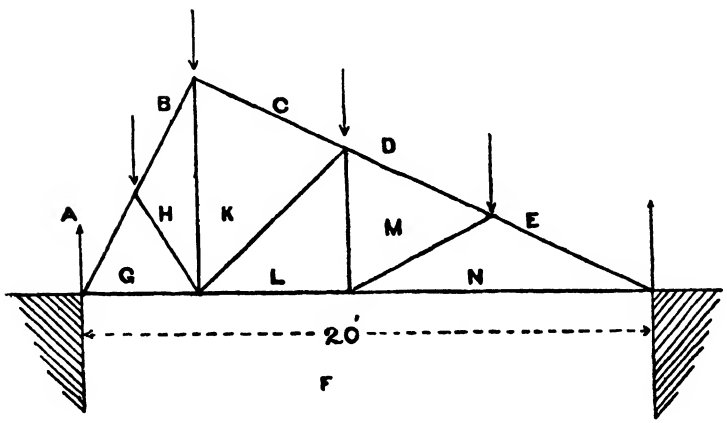
or

What are the main points to consider in designing foundations of machinery? Illustrate your answer by examples.

3. Draw to scale a sectional plan of an hexagonal chimney required for a range of four Lancashire boilers at height of 30 feet above G. L., giving dimensions.

4. A rolled joist 20 feet long is supported symmetrically at two points 10 feet apart and carries a uniformly distributed load of 12 tons over the whole length. Draw the Bending Moment and Shear diagrams.

5. A roof truss for a workshop, 20 feet span, angles of roof 60° and 30° on the two sides respectively, is shown in the figure. Draw the stress diagram and tabulate the stresses in the various members. The weight of the roof covering, together with work-people, may be taken at 18 lb. per square foot, and the distance apart of the trusses 8 feet.



Preliminary Examination, Engineering Diplomas, 1926.

Subject:—SURVEYING.

Paper-setter and Examiner—Chuni Lal Sarkar, B.E.

Time—Three Hours. Full Marks—100.

1. In chain surveying what are the main considerations to be borne in mind for triangulation? Explain fully by means of sketches. What are offsets? Describe the appliances that are used in measuring offsets, noting how each such appliance is used.

2. What errors is a prismatic compass liable to and how would you guard against them? Mention the permanent adjustments required for the Y-Level.

3. In making a chain survey of a plot of ground, the following measurements were made:—*A* to *B*=530 feet, *B* lying due north of *A*; *B* to *C* (going westwards) but *not* due west=425 feet; *C* to *A*=622 feet; *C* to *D* (going southwards)=380 feet and *D* to *A*=555 feet. Plot to a scale of 200 feet=1 inch and find the length of the diagonal *DB*; also determine the bearings of *BC*, *CD*, and *DA* by the use of the protractor.

4. Explain the following terms:—Tie line, Bearing, Parallax, Datum line, Bench mark, Reduced level, Check level and Line of Collimation.

5. Explain the method of traversing with a theodolite by adopting a fixed meridian. What checks are applicable when a circuit is completed and how is the traverse usually plotted?

6. Explain how you would lay out a curve of radius 2,000 feet by chords of 100 feet without the use of any angular instruments.

Preliminary Examination, Egineering Diplomas, 1926.

Subject:—PHYSICS FOR ENGINEERING DIPLOMAS.

Paper-setter and Examiner—B. C. Gupta.

Time—Three Hours. Full Marks—100.

ALL QUESTIONS CARRY EQUAL MARKS.

Marks are allotted for neatness, method and brevity.

GROUP A.

ANSWER FOUR QUESTIONS ONLY.

1. What are the three different states of matter and what are their subdivisions? Define and give an example of each.

   Give some of the general and specific properties of matter.

2. Define a lever, and give it three classifications. Give four practical examples of the use of a lever. A rod is attached to a wall by a hinge, and a mass of 3 lbs. is suspended at a point 2 inches from the hinge; at what distance must a force equal to the weight of 2 ounces act upwards to produce equilibrium?

3. Describe with sketches, giving the underlying principle, and mentioning the specific uses to which they are put, of the following:—

   (*a*) Mercury Thermometer. (*b*) Aneroid Barometer. (*c*) Mercury Pump. (*d*) Compensating Pendulum.

4. What do you understand by the mechanical equivalent of heat? Describe Joule's experiment with respect to the above.

A leaden ball falls on the ground from a height of 3,860 feet. Supposing that all the heat generated is communicated to the ball, what would be its rise in temperature? (The specific heat of lead is 1/30 that of water.)

5. Give the laws of:—(*a*) Transmission of light. (*b*) Reflection. (*c*) Refraction.

What do you understand by (*a*) Umbra. (*b*) Penumbra? How do you account for lunar and solar eclipse?

Sketch and describe Bunsen's photometer.

6. Give examples of transmission of sound in (*a*) Air. (*b*) Water. (*c*) Solids. What influences the intensity of sound? On some perfectly clear days the range of sound is far less than ordinarily—account for this phenomenon.

GROUP B.

ANSWER FOUR QUESTIONS ONLY.

1. Sketch, describe and give the working principles of the Wimshurst Influence Machine.

2. The total quantity of *Induced Electricity* is equal and opposite to the *Inducing Charge* of a body, provided the charged body is wholly surrounded by the induced body. Explain how you would prove this experimentally.

3. What is the difference between a Primary and Secondary Battery? What other names does the latter go by commercially?

Describe at least one of each type of battery and state the chemical actions which occur.

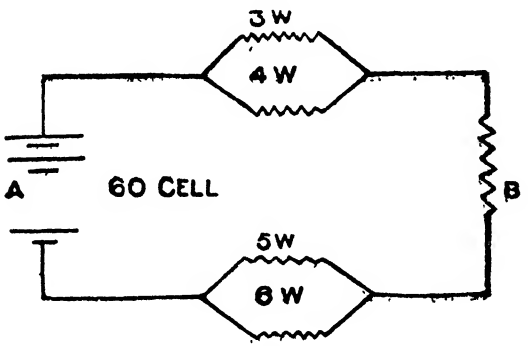
4. Describe the working principle of the Tangent Galvanometer. In determining the electrochemical equivalent of copper, a Tangent Galvanometer the working constant of which is 0.4, is connected in series with

a plating bath and a battery, and it is found that in 15 minutes 0.099 gramme of copper is deposited and the deflection of the galvanometer is 40°. Determine the electrochemical equivalent of copper.

5. Give the laws of magnetic force.

How much must the distance between two magnetic poles of 16 and 6 units strength, 4 cms. apart, be changed, so that the force exerted between is reduced 33 per cent.

6. You are given the following data:—



A { E cell = 2·2 volts each.
R cell = ·03 w. each.

B { l = 3 0 yds.
a = ·03 sq. in."
ρ ·6 × 10—⁶

Find current in amperes through B.

Preliminary Examination, Egineering Diplomas, 1926.

Subject:—CHEMISTRY FOR ENGINEERS.

Paper-setter and Examiner—C. A. King, B.Sc., A.R.C.Sc., M.I.M.E., M.I.S.E., M.I.E.

Time—Three Hours. Full Marks—100.

ANSWER SIX QUESTIONS ONLY.

1. What do you understand by such expressions as 1st class, good 2nd class, 2nd class and 3rd class Indian coals? Name some seams or localities from which you can obtain the above-mentioned coals with their current prices per ton at the collieries.

   What kind and quantity of coal would you indent for with a view to burning 4 lacs of ordinary bricks in clamps?

2. Name some of the Indian coal seams from which 1st class hard coke is being manufactured at present.

   What considerations would affect your choice when purchasing coke for a smelting furnace?

3. What are the principal reagents used for drying gases and on what does the action depend in each case? What substances would you use for drying the following gases: chlorine, ammonia, and sulphur dioxide?

4. How would you proceed to determine the suitability of a given water for boiler purposes?

5. In what respects are the following metals important to the engineer:—Copper, Zinc, Tin, Lead and Aluminium? Give one example in each case of an important application.

6. What composition and mechanical tests would you specify to ensure obtaining suitable material for the steel girders of a wide span railway bridge for heavy traffic.

7. Give a short account of the chief defects met with in iron castings. What are the causes of these defects, and what measures should be taken to avoid them?

8. What are the essential characteristics of a blast furnace and a reverberatory furnace? Describe the use of each of these in industry.

9. What is the principal ore of lead? Describe briefly the process by which lead is extracted from this ore.

Preliminary Examination, Engineering Diplomas, 1926.

Subject:—ELECTRICAL ENGINEERING.

Examiner—B. C. Chatterjee, B.A., B.L., B.Sc., M.I.E.E.

Time—Three Hours. Full Marks—100.

ANSWER ANY SIX QUESTIONS.

1. Two equally charged discs repel each other with a force of 32 dynes, the distance between them being 2 cm. Calculate the amount of charge on each, assuming them to be so small in proportion to the distance separating them that the laws of radiant action apply.

2. Describe with neat sketches an ohmmeter and a watt-meter and explain the constructional difference between the two.

3. What do you understand by the voltage regulation of a generator and the percentage of over compounding?

   A machine gave 220 volts at no-load, and 250 volts at full-load at the same speed. Find the percentage of over compounding of the machine.

4. Draw a Switch Board Diagram for two three-phase alternators running in parallel and supplying power to a three-wire circuit.

5. Design a shunt motor starter for a 20-B.H.P., 220-volt shunt motor which takes a current of 76 amperes for running normally at full-load. If the maximum starting current has not to exceed 114 amperes, determine by a Graphical Method the number of steps required for the starting resistance, and the resistance of each step. The armature resistance equals .18 ohm.

6. Describe the Ilgner system of speed control of motors.

7. Prove that in an alternating current circuit, $P = E I \cos \phi$.

8. Describe the method of adjusting the load of two alternators in parallel. Does it differ from the method of load division of D. C. Generators and if so, why?

9. What is a choking coil? Describe some of its uses.

10. Deduce an equation for determining the energy stored in the dielectric field.

Third Year Diploma Annual Examination, 1926.

Subject:—APPLIED MECHANICS.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS.

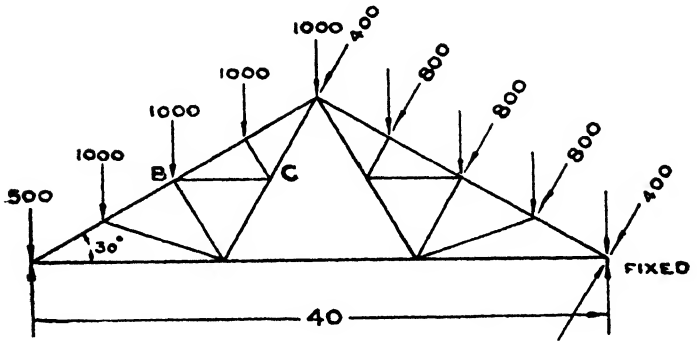
1. A reinforced concrete beam is 10 inches wide and effective depth 18 inches. Calculate the economic area of reinforcement if the safe stress in concrete is 600 lbs./sq. inch and in steel 16,000 lbs. inch. What uniformly distributed load per ft. run can the beam carry including its own weight over a span of 20 ft.?

   Modular Ratio $\frac{Es}{Ec} = 15$

2. The mean radius of the balls of a Hartnell governor weighing 3 lbs. each is 8 inches at 300 r.p.m. The sleeve has to move $\frac{1}{2}$ inch higher at 310 r.p.m., and $\frac{1}{2}$ inch lower at 290 r.p.m. The arms of the bell crank are equal. Find a suitable spring.

3. A cantilever beam of length L ft. carries an uniformly distributed load of W lbs. per ft. run and is propped at the free end to the same level as the fixed end. Find the deflection at the centre. How does the stiffness compare with that of a freely supported beam of the same span and the same loading? For equal central deflection which will carry a greater load?

4. The figure shows a roof-truss of 40 ft. The rafters are



each divided into 4 equal parts. The dead loads and wind loads are as shown in lb. Calculate the stress in the horizontal member BC.

5. A solid strut of mild-steel is 1.5 inches in diameter, and has both ends fixed. Find the length for which the breaking loads by Rankine and by Euler will be equal. Take E=13,500 tons/sq. inch.

6. A plate-girder carries an uniformly distributed load of 1 ton per ft. run over a span of 80 ft. If the depth of the girder be 40 inches, find the necessary area of the flanges.

If the web plate be $\frac{3}{4}$ inch thick, is the girder strong enough to resist failure by buckling?

Third Year Diploma Annual Examination, 1926.

Subject:—HEAT ENGINES.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

1. An Engine of 300 H.P. has a mean speed of 160 revolutions per minute. The fluctuation of energy is 1/10 of work done by the engine per revolution. Taking the radius of gyration of the flywheel to be 3 ft., find its weight in order that the fluctuation of speed may not exceed 2 per cent. of the mean speed.

2. The air leakage into a surface condenser and its connections amounts to 4 lbs. per 10,000 lbs. of steam used. The steam consumption is 28,800 lbs. per hour. The vacuum in the air pump suction is 28.1 inches (barometer 30 inches), and the temperature is 35°C. Compute the capacity of the air pump which removes both the air and the condensed steam, in cu. ft. per minute, taking the volumetric efficiency as 80 per cent.

Pressure of steam at 35°C. = 0.814 lbs./sq. inch.

3. How does the radial valve gear differ from Stephenson's link motion? How is the power varied by its means or the direction of rotation changed? What is the effect on lead?

4. What are the chief points essential for the efficient working of a Lancashire boiler?

A boiler evaporates 8 lbs. of water per lb. of coal burnt into dry saturated steam at a pressure of 160 lbs./sq. inch. Temperature of feed supply is 60°F. Find the equivalent evaporation in standard evaporation units. If the calorific value of coal used is 14,000 B. Th. U. per lb., what is the thermal efficiency of the boiler?

5. Calculate the diameter of cylinder, and quantity of oil per hour required for an oil engine using crude oil of calorific value 18,000 B. Th. U. per lb. from the following data:

B. H. P. 50, r.p.m. 180, stroke=$1\frac{1}{2}$ diameters.

Thermal efficiency 0.27, Volumetric efficiency=0.7.

Working on fourstroke cycle.

6. The initial pressure of the air in a compressed air motor is 75 lbs./sq. inch, and the final pressure is 15 lbs./sq. inch. To what temperature must the air be pre-heated in order that the temperature after expansion may be 2°C. (35.6°F.)?

Take $n=1.3$.

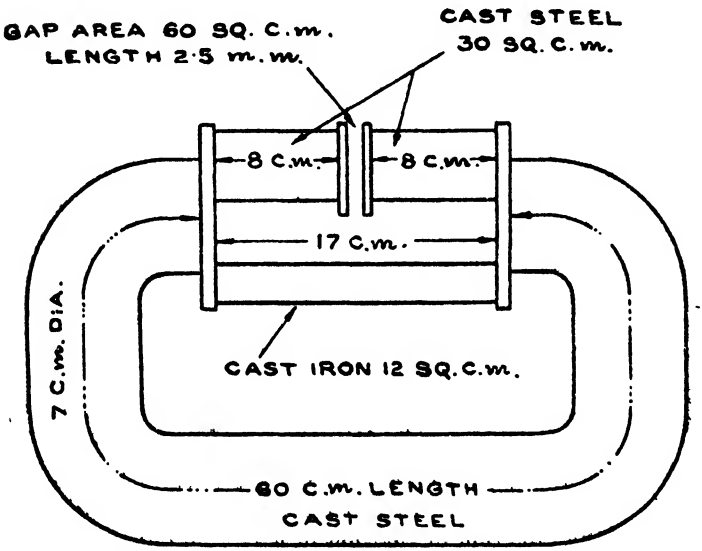
Third Year Diploma Annual Examination, 1926.

Subject:—DIRECT CURRENT.

Time—Three Hours. Full Marks—100.

ANSWER SIX QUESTIONS ONLY.

1. What is a magnetic circuit? State the law which a magnetic circuit obeys, and compare this law with that obeyed by an electric circuit.



DENSITY IN THE GAP, B_g	1000	7000
μ FOR CAST STEEL	500	155
μ FOR CAST IRON	272	74·8

The accompanying diagram shews the dimensions of a magnetic circuit in which the useful flux passing through the air-gap is shunted through the cast-iron

rod as shewn. What percentages of the total flux in the Yoke are shunted when the flux density B in the air-gap is 1,000 and 7,000 lines per sq. c.m. respectively? When B in the gap is 7,000, what is the value of B in other parts of the circuit; and what the total ampere turns required?

2. Define magnetic hysteresis and the hysteresis constant of a sample of iron. Show that there is a loss of power when a sample of iron having hysteresis is carried through cycles of magnetisation.

A transformer core contains 96 cubic inches of iron ($\eta = 0015$.) An c. m. f. of 133 cycles per second is impressed on the transformer, the maximum flux density B is 3,500 gausses. Calculate the power loss due to hysteresis in the core.

3. Why are the brushes of modern D. C. machines mostly of carbon and why are they generally moved from the neutral position?

What factors determine the correct position of the brushes?

If the direction of rotation of an interpole generator is reversed so that the polarity of the main poles remain unchanged, will it be necessary to reverse the interpole connections? Give reasons for your answer.

Shew by a diagram the mutual relationship between the polarity of the main poles, that of the interpoles and the direction of rotation of a D.C. shunt motor.

4. Establish the formula $E = p \phi \frac{N}{2} \times$ r. p. s. $\times 10^{-8}$

A 4-pole D. C. generator driven at a certain speed has an average induced voltage per conductor of 2 volts. The current per conductor is limited by heating to 10 amperes. The generator delivers to the line 40 amps. at 120 volts. What is the type of winding, and what is the number of conductors on the armature?

What would be the change in the machine if the armature winding only were changed without changing any other factor? Will there be any change in its power output?

5. A 30-h.p., 120-volt, 900-r.p.m. shunt motor has an efficiency of 88 per cent. The voltage drop in the armature is 4 per cent., and the exciting current is 1.4 per cent. of the full-load current.

   (*a*) Find the full-load current in the line, the armature current, the resistance of the armature.

   (*b*) Find the torque developed at the driving pulley at full load in pounds foot.

   (*c*) Specify the starting resistance to keep the current down to 1.25 times the full-load current, and what will be the starting torque under these conditions?

6. State Kelvin's Law used in the choice of the section of a line to transmit a given current over a given distance.

   A station owner has to deliver 16.5 k.w. for 1,200 hours each year at 220 volts over a special line at a distance of one mile from the station. Determine the total outlay in the line from the following data:

   Cost of power at the switchboard 2.5 annas per k.w. hour.

   Total cost of line 2.25 times the cost of copper alone.
   Annual rate of interest, depreciation and maintenance of the line all together at 15 per cent.

   Cost of Cu = -/14/- a lb.

7. Define the following terms in connection with a lead storage battery:—

   Capacity, voltage efficiency, ampere-hour and watt-hour efficiencies.

On what factors do the efficiency, internal resistance and capacity of a secondary cell depend?

A secondary cell having a rated capacity of 100 amp.-hours at 8-hour rate, has a no-load terminal voltage of 2.15 volts and an internal resistance of 0.012 ohm. The same cell when re-charged after the nomal discharge takes a current of 14.5 amps. for 8 hours. Find

(*a*) The volt efficiency.

(*b*) The amp.-hour capacity.

(*c*) The watt-hour capacity.

(*d*) The discharging current at normal rate.

(*e*) ,, ,, at 4-hour rate.

8. In what respects do an ammeter and a voltmeter differ and resemble each other? Describe with a clear diagram how the same instrument can be used as a multi-range (3-range) ammeter and also a 3-range voltmeter.

A certain millivoltmeter, reading up to 100 millivolts, is to be used to read up to 10 amperes and also up to 150 volts. How will you do so and what resistances will you use in each case?

9. Define intensity of illumination, illuminating power and efficiency of a glow lamp; and shew how you will use a photometer to compare the candle powers of two lamps. Compare the cost of light (*a*) per lamp-hour, (*b*) per C. P.-hour, for the following 220-volt lamps including the cost of renewals:

Type of lamp	C. P.	Watts consumed	Price Rs. A. P.
Carbon	16	60	0 8 0
Tantalum	29	55	1 8 0
Tungsten	48	65	1 12 0
Nerust	130	0.9 amps.	1 4 0

Price of energy is 3 annas per B.O.T.

10. Describe the principle of Series-parallel control in tramway traction, and discuss its advantages with regard to energy-consumption.

11. Power is required at a pressure differing from that of the supply.

Enumerate the various methods of doing this and discuss the relative merits of the two best methods.

A current of 200 amps. at 150 volts is required from 110 volts supply. Calculate the sizes of the machines required for doing this by the best method you think, assuming the efficiency of your machines, say 85 per cent.

Third Year Diploma Annual Examination, 1926.

Subject:—ALTERNATE CURRENT.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

1. Explain what is meant by Eddy Current in electrical machines and how they are produced. Is the Eddy Current of any benefit to the machine?

The Eddy Current loss in a transformer is 200 watts when operated on 50-cycle mains. Calculate the Eddy Current loss when operated on a 25-cycle circuit, the voltages being the same in both cases.

2. Describe the action of the equalising busbar in the parallel running of compound generators.

Explain clearly if you can run a flat compounded generator in parallel with an over-compounded one?

3. Compare carefully the operation characteristics of the different kinds of D.-C. motors and describe the kind of work for which each type is suitable.

4. The phase E. M. F. of a 3-phase alternator is 220. The alternator is running in star connection. The induction motor which is being worked from the same generator is started through an auto-transformer having a transformation ratio of 2:1. Find the voltage across each phase of the motor if it is Δ connected.

5. A choking coil is required to enable a number of incandescent glow lamps to be run at 125 volts from a 225-volt A.-C. circuit. If the effective resistance is 5 ohms, find its reactance and efficiency of the stopping-down.

6. Calculate the capacity current of a concentric cable 10 miles long, 0.25 m. f. d. per mile, when supplied at 6,600 volts 5,000 . .

   If a non-inductive load of 100-K.W. comes on the cable, what is the new value of the current therein?

7. What is meant by all-day efficiency of a transformer? Find the all-day efficiency of a 20-K.V.A. 2,200: 200-volt transformer, the no load input is 250 watts. The resistances of the primary and secondary are 1 and 0.02 ohm respectively.

8. Explain clearly why a synchronous motor stops when 'out of step.' What are the advantages of a synchronous motor and where is it used?

9. Explain with diagram how a 30-H.P. squirrel-cage motor is started on the star-delta method. What is the starting current and starting torque?

Diploma of Licentiate in Mechanical Engineering, 1926.

Subject:—MACHINE DESIGN.

Examiners—Capt. H. Whittaker, B.Sc., A.R.C.Sc., A.M.I.C.E., A.M.I.M.E., A.M.I.E.E.; Principal C. A. King, B.Sc., A.R.C.Sc., M.I.M.E.; Prof. L. D. Coueslant, B.Sc., A.M.I.M.E., M.I.E.

Time—6 days—6 hours per day. Full Marks—400.

1. All calculations are to be made for the following specification.

   Compound Steam Engine:—

   60 I.H.P. 500 r.p.m.; non-reversing; Vertical; Totally Enclosed; Steam Pressures 120 (gauge) to 26 inches of Mercury Vacuum; Forced Lubrication circulating 10 pounds of oil per H.P. Hour; Cranks at right angles; Both Valves of Piston Type; Cyclical Speed Fluctuation 1/100; Overall Speed Fluctuation 1/40.

2. Draw a Centre Line Diagram of above engine showing Cylinder and valve casing walls, and crank shaft in their correct relative positions.

3. Prepare working drawings of either

   (*a*) The forced lubrication system including the pump and filter; or

   (*b*) The governor including the throttle valve.

Diploma of Licentiate in Mechanical Engineering, 1926.

Subject:—PRIME MOVERS.

Examiners—Capt. H. Whittaker, B.Sc., A.R.C.Sc., A.M.I.C.E., A.M.I.M.E., A.M.I.E.E.; Principal C. A. King, B.Sc., A.R.C.Sc., M.I.M.E.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

1. In a Meyer valve gear the travel of each of the valves is 6 inches. The outside lap of the main valve is $1\frac{1}{4}$ inches and the lead $\frac{1}{8}$ inch. The expansion valve eccentric leads the engine crank by 180 degrees. Show how to find the relative motion of the two valves, and find the lap (1) of the expansion valve when cut off occurs at one third of the stroke. Neglect the obliquity of the connecting rod.

2. It is required to develop 2,000 horse power in a power station which is situated 100 miles from the source of energy.

   (A). The source of energy is water having an available fall of 740 feet. Compare the volumes of water used in the two following systems:—

   (*i*) The water is used at the source in a turbine and electricity generated at 2,000 volts by plant which has an overall efficiency of 75 per cent. The voltage after transmission to the power station is 1,800 volts.

   (*ii*) The water is conveyed from the source through a pipe line 5 feet diameter to a turbine plant placed in the power station and electricity is there generated at 1,800 volts. The drop of pressure head in the pipe due to friction may be taken as $0.4\ v^2$ feet per mile, v being the velocity of the water in the pipe in feet per second. The plant in the power station has an efficiency of 75 per cent.

(B). The source of energy is coal having a calorific value of 7,800 pound calories per pound. Compare the weights of coal used in the two following systems:—

(*i*) The coal is used at the source in a steam plant to generate electricity at 2,000 volts and the overall plant efficiency is 15.1 per cent. There is a 10 per cent. loss in voltage in transmission.

(*ii*) The coal is carried by rail from the source to the power station in trucks which weigh one ton each and contain 10 tons of coal. A plant is installed in the power station and electricity is generated there at 1,800 volts, the plant efficiency being 15.5 per cent. The frictional resistances on the railway may be taken as 25 pounds per ton and the efficiency of the locomotive hauling the coal train as 4 per cent.

3. A De Laval turbine is set to work between pressure ranges of 60 lb. and 15 lb. per square inch absolute. The steam supply is initially dry and saturated. The nozzles are inclined at 20 degrees to the plane of the rotor.

Draw the velocity diagram and find:—

(*i*) the efficiency of the pair,

(*ii*) the efficiency when the blade speed is one half of the speed which would give the maximum efficiency.

4. What is the object of mixing steam with the air drawn through a suction gas plant and what effect has an excess of steam on the quantity of gas produced?

A suction gas plant produces gas having the following percentage volumetric composition:—

CO 27·3, H_2 15·2, CH_4 1·1, CO_2 3·9, N_2 52·0.

Calculate the volume of air theoretically required to burn a cubic foot of this gas.

If the gas were delivered to the cylinder of a gas engine in which the mixture contained 50 per cent. excess air, what would be the calorific value of a cubic foot of cylinder mixture given that the calorific values of CO_2, H_2 and CH_4 are respectively 190, 162 and 535 pound calories?

5. A CO_2 refrigeraior works between pressure limits of 850 lb. per square inch upper and 425 lb. per square inch lower (absolute pressure). Corresponding temperatures of vaporisation, 21.5 deg. C. and −7 deg. C. The mean specific heat of the CO_2 liquid between the temperatures is 0.63, and the latent heats are 34.55 C.H.U. and 59.77 C.H.U. at the upper and lower limits respectively. Find the theoretical coefficient of performance when the CO_2 stuff is just dry at the end of compression. Assume the boundary lines of the temperature-entropy diagram to be straight.

6. Describe briefly how you would conduct a test on a simple steam engine of about 20 horse power stating clearly the measurements and readings you would take and the calculations you would make. What would you expect to learn from the result?

7. A hydraulic lift has a ram 6 inches in diameter and draws water from a main in which the pressure is maintained constant at 400 lb. per square inch. The pipe leading from the main to the lift is $1\frac{1}{2}$ inches diameter and experiment shows that the drop of pressure in the pipe due to friction of the water is given in lb. per square inch by the expression $0.5\ v^{1.7}$ where v is the velocity of the water in the pipe in feet per second.

Plot, on a gross load base, curves showing for gross loads from one ton to 5 tons:—

(*i*) the speed of lifting

(*ii*) the effective horse power of the lift

(*iii*) the efficiency.

8. What are the advantages derived by the use of "overhead" instead of "pocket" valves in motor car engines. Show by a neat sketch an overhead valve in a cylinder head and indicate clearly the manner in which the valve is operated.

9. Sketch *one only* of the following:—

   (*i*) The nozzle and deflector for a large Pelton wheel.

   (*ii*) A Runner suitable for a low head turbine.

   (*iii*) Any type of governor for use with a Pelton wheel.

Diploma of Licentiate in Mechanical Engineering, 1926.

Subject:—APPLIED MECHANICS.

Examiners—Capt. H. Whittaker, B.Sc., A.R.C.Sc., A.M.I.C.E., A.M.I.M.E., A.M.I.E.E.; Principal C. A. King, B.Sc., A.R.C.Sc., M.I.M.E.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS ONLY.

1. Sketch and describe the arrangements for feed and screw cutting in an ordinary lathe. Show clearly the method of gripping and releasing the leading screw.

2. Show that the maximum shear stress on the section of a rectangular beam is one and a half times the mean shear stress. A beam has a depth of 6 inches, a width of 3 inches, and a span of 6 feet. At the centre of the span it carries a load of 1,000 lb. Find the shear stress and the normal stress at a point 2 inches from the neutral axis on a section perpendicular to the axis of the beam at a distance 2 feet 6 inches from one support.

3. A rectangular concrete beam 15 inches deep and 9 inches wide is reinforced by two steel bars, each $1\frac{1}{4}$ inches square, the centres of the steel bars being 2 inches inside the tension face of the concrete beam. The span of the beam is 16 feet and it carries a uniformly distributed load. If Ec= 3,000,000 lb. per square inch and if Es=30,000,000 lb. per square inch, find the total load the beam can support if the maximum compressive stress in the concrete is not to exceed 3,000 lb. per square inch and the maximum tensile stress in the steel 12,000 lb. per square inch. You may assume a linear relation between stress and strain for the concrete.

4. A coupling has to transmit 10,000 horse power at 120 revs. per minute. The shaft is hollow and the internal diameter is 0.6 times the external. There are eight bolts. Assuming your own proportions where necessary find the diameter of the shaft and of the bolts.

5. A beam of fir, 16 inches square in cross section, is carried by two supports with a span of 18 feet. A lifting tackle is attached to its centre, and the greatest load which comes upon the centre is 15 tons. Take E=700 tons per square inch.

Find:—(*a*) the maximum intensity of tensile stress produced.

(*b*) the deflection at the centre of the beam.

(*c*) the work done in inch pounds in deflecting it.

6. Energy at the rate of 40 horse power is to be transmitted from an accumulator through a pipe, 4 inches diameter and 5,000 feet long. If the loss is to be 2 per cent., find the diameter of the ram which is loaded with 120 tons.

7. A loaded truck weighing 10 tons rests on two axles. The axles are supported by the wheels, 5 feet apart, and the centres of the axle boxes are 4 feet 4 inches apart. Darw the curves of bending moment for one axle, and find the necessary diameter of the axle so that the stress may not exceed 3 tons per square inch.

8. Calculate the size of a shaft which will transmit 50 horse power at 110 revolutions per minute. The shearing stress is to be limited to 3 tons per square inch and the twist of the shaft is not to exceed one degree in $7\frac{1}{2}$ feet of length of shaft. The modulus of rigidity of the material is 5,000 tons per square inch. Assume the twisting moment to be uniform.

9. One end of a beam is securely built in, while the other end rests on a cast iron column at the same level. The span is 5 feet and the load on the beam per foot run (including its own weight) is 1,600 lb.

Determine the force on the column, the maximum bending moment and the maximum shearing force on the beam, and find the positions of the points of zero bending moment.

Diploma of Licentiate in Electrical Engineering, 1926.

Subject:—ELECTRICAL DESIGN.

Examiners—Capt. H. Whittaker, B.Sc., A.R.C.Sc., A.M.I.C.E., A.M.I.M.E., A.M.I.E.E.; Prof. B. C. Chatterjee, B.A., B.L., B.Sc., M.I.E.E.; Prof. R. S. Jain, B.Sc., A.M.I.E.E.

Time—6 days—6 hours per day. Full Marks—400.

ANSWER ANY ONE OF THE FOLLOWING QUESTIONS.

1. Make a preliminary design and estimate of a power plant to supply the University Town having the following loads (*a*) Street lighting 4 miles of main road, (*b*) Pumping load, (*c*) Lights and Fans for the Hostels and Hospital, (*d*) Fans and Lighting for Staff quarters, (*e*) Light and Power supply to the Colleges. Assume necessary data.

2. Design a 32 volt 109 ampere 600 r.p.m. country house lighting generator, giving the assembly drawings, detail drawings of armature winding, circuit connections, armature core and commutator construction.

   What changes in the design and dimensions of the above machine will take place if you choose to design the above machine as an interpole machine as compared to the machine without interpoles. Suppose you had another house about a couple of furlongs away from the house where you have installed the generator and you want to supply about 1 K. W. to the other house from the same generator. If you carry current at 32 volts there is a considerable line drop loss and cost. What measures will you take to reduce them all ?

3. Design a 10 H.P. 440 volt 3 phase 50 cycle 1,000 r.p.m. squirrel cage induction motor. Give general assembly drawings along with its rotor construction in detail and complete stator winding.

Diploma of Licentiate in Electrical Engineering, 1926.

Subject:—ELECTRICAL ENGINEERING (PAPER I).

DIRECT CURRENT ENGINEERING.

Examiner—G. R. Boscolo, Esq.

N.B.—*Only eight questions to be attempted of which the first four carry most marks.*

Resistance of copper to be taken 0.66 michrom per inch cube. Weight of copper 0.32 per cube inch.

Time—Three Hours. Full Marks—100.

1. A special D. C. Shunt Motor drives an alternator to obtain various frequencies over a wide range of speed. The motor can either be supplied by 220 volts or 440 volts by means of a throw over switch. The control panel has the usual instruments, starter and suitable rheostat. Describe how you would change over from 220 to 440 volts without shutting down the motor.

2. Give a diagrammatic sketch for the successful operation of 2 level compound generators in parallel. Your sketch should show the necessary instruments and switches.

3. Describe how the field and armature reaction in a motor causes rotation. Illustrate your answer by a sketch.

4. When is the Hopkinsons Test utilized? Describe the system and give a diagram of connection.

5. A town is supplied with electrical energy from a Central Power Station. The supply required at various points is (*a*) 900 KW, (*b*) 1,500 KW, (*c*) 500 KW, (*d*) 1,000 KW. If the current density of the feeders is not to be more than 1,000 Ampere per square inch and the distance from the power station to (*a*) 1,000 yards, (*b*) 500 yards, (*c*) 2,000 yards and (*d*) 1,500 yards, what must be the size of feeders so that the pressure drop does not exceed 2 per cent?

6. A 3-wire system has the following connections:

(*a*) Between position and neutral 300 Lamps 16 C.P. 100 Volts (3.5 watts per C.P.) 2 Motors 5 HP 100 Volts.

(*b*) Between negative and neutral 100 Lamps 25 C.P. 100 Volts (3.5 watts per C.P.) 4 Arc Lamps 10 amps. each. 12 heaters 5 amps each.

What must be the size of rotary balances required?

7. Describe briefly how the C. P. of a lamp is measured. Two arc lamps give out 900 C.P. at an angle of 60°. Assuming the minimum illumination to be 05 candle foot, find distance between poles.

8. A shunt motor is supplied with 100 amps. at 100 volts and it is found that the stray power is ½ HP. Given armature resistance 4/65 ohms and shunt resistance 40 ohms, determine the Brake Horse Power, the electrical and commercial efficiencies.

9. It is required to raise water out of a mine 800 feet deep at the rate of 8,000 gallons per hour. If the combined efficiency of pump and D. C. Motor is 58 per cent. and 10 per cent. is lost in pipe friction, what current would be required with 500 Volts at motor terminals?

10. If the generating cost is an anna per unit and the cost of copper is Rs. 1,000 per ton, what would be the cheapest section for a bare copper continuous current feeder 1 mile in length transmitting a load of 100 KW. at a pressure of 400 Volts taking the interest and depreciation at 10 per cent. per annum?

Diploma of Licentiate in Electrical Engineering, 1926.

Subject:—ELECTRICAL ENGINEERING (PAPER II).

ALTERNATE CURRENT.

Examiner—Prof. B. C. Chatterjee, B.A., B.L., B.Sc., M.I.E.E.

Time—Three Hours. Full Marks—100.

ANSWER FIVE QUESTIONS OF WHICH QUESTION 1 MUST BE ONE.

1. A bad earth is indicated in the negative side of the electrical network of your University Power Station. Describe carefully how, beginning from the Power House (with the live line) you would proceed to detect the fault which ultimately was found out to be in a student's room in Hostel No. II.

2. What do you mean by current resonance in an A. C. circuit? What relation of the constants of the circuit produce such a resonance? If such a resonance is at all desirable for an A. C. circuit, give reasons.

The load end of an A. C. transmission line is at 220 volts and has got a resistance of 11 ohms, and an inductive and capacity reactance of 2.2 ohms each, all in parallel. Find out the current in the line. Neglect the line inductance and capacitance.

3. It is required to limit the starting current of a 440 volt, 3 phase induction motor to half its value if directly switched on to the main. Find the voltage transformation ratio of the auto-transformer used for the purpose. What will be the value of the starting torque in the latter case? The induction motor is star-connected.

4. Describe the principles and procedure in detail of the various methods of starting 3 phase synchronous motors adopted in your Laboratory.

5. Find the apparent input in K.V.A. of a 50 h.p. 3 phase synchronous motor supplied at 225 line volts, if its efficiency is 90 per cent., and its p.f. 90 per cent. leading, at the load. Also find the full-load line current and phase current, assuming the machine to be mesh-connected.

6. Describe the construction and principle of operation of the synchroscope you have used in your Laboratory. Why does a pair of lamps always accompany the synchroscope?

7. What is a static balancer? Explain clearly its principle of balancing action in conjunction with a three-wire D. C. generator.

The two outers of a three-wire D. C. transmission line has got a resistance 0.25 ohms each. The neutral is of $\frac{1}{2}$ the section of the outers. The currents in the positive and negative outers are 60 and 40 amps. respectively. What is the drop on each side of the circuit?

8. Justify—"The maximum demand system of tariff has got a reasonable economic basis."

Prepare a bill for a quarter for the following consumptions of electrical energy at the following rates:—

Consumption—

Load.	Units per day.	M. D.
Lighting	5	——
Fan	8	——
Lift motors ...	80	M. D. 20 Kw.

Rate:—Lighting and Fan—3 as./unit.

Motor—Rs. 8 per Kw. M.D. per month+1 anna/unit.

9. Determine the size of the synchronous motor required to raise the p.f. from 0.6 to 0.8 of 1,000 K. V. A. set and thus to add 200 Kw. of additional motor plant without increasing the load in the line feeding the installation.

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AND

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